N69-10810

RESULTS OF AIRBORNE SURVEY OF NO_2 AND SO_2 OVER LOS ANGELES BASIN

Barringer Research Limited
Rexdale, Ontario, Canada

September 1968

N69-10810

RESULTS OF AIRBORNE SURVEY OF NO_2 AND SO_2 OVER LOS ANGELES BASIN

PREPARED FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER, HOUSTON
AND
THE UNITED STATES GEOLOGICAL SURVEY
IN ASSOCIATION WITH
THE GEOGRAPHY DEPARTMENT OF THE UNIVERSITY OF CALIFORNIA

CONTRACT NO. NAS9-7958

PREPARED BY

BARRINGER RESEARCH LIMITED
304 Carlingview Drive
Rexdale, Ontario, Canada

TR-68-68

SEPTEMBER - 1968

NOTICE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF DRAWINGS

1. GENERAL AND BACKGROUND

An airborne survey of atmospheric nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) was performed over the Los Angeles Basin including Los Angeles and Riverside Counties. The purpose of the survey was to evaluate the Barringer correlation technique as a means of remotely measuring concentrations of atmospheric contaminants. This work formed one segment of a large scale multi-sensor testing program managed and directed by the United States Geological Survey in association with the Geography Department of the University of California, Riverside.

The objectives of the larger program was to test the utility of various remote sensing techniques for space applications as related to the Geography discipline of the U.S.G.S./N.A.S.A. Earth Resources Program. Two contrasting areas in southern California were designated for intensive multi-sensor testing during the period May 21st to June 4th inclusive namely (1) the city of Los Angeles showing a cross section of residential developments of wide range and quality, industrial areas, portions of transportation network, commercial districts and air pollution and (2) a concentration of irrigation, agriculture and small towns in the Coachella and Imperial Valleys in the Salton Sea portion of the Colorado Desert, about 100 miles from coastal Los Angeles.

The work reported on herein is confined to air pollution measurements in the Los Angeles Basin over the period May 21st to May 24th inclusive. The aircraft used for pollution sensing was an Aero Commander 500A based at Riverside Municipal Airport.

This report describes the airborne measurement procedures, the flight lines or survey patterns flown, the meteorological conditions at the time of flight, the method of data reduction and the end results obtained. These results are compared with simultaneous ground based measurements provided by A.P.C.D. (Air Pollution Control District) stations.

2. FLIGHT PATTERNS AND SCHEDULES

Flight patterns were chosen to provide a general picture of atmospheric pollution over the greater Los Angeles area encompassing the western portion of Riverside County, the San Fernando Valley and the metropolitan Los Angeles area south to Long Beach. Consideration was also given to the selection of each leg or line of the patterns to obtain pollutant profiles which would overlay A.P.C.D. stations and hence provide most meaningful comparisons of ground level pollutant concentrations. For the last day of measurements, Friday May 24th, data runs were made for SO_2 and NO_2 along the same north-south and east-west flight lines used by the N.A.S.A. 240A (flown on the same day) aircraft. Tables 1 and 2 summarize the flight numbers, flight durations and cloud conditions. Useful survey time was limited by heavy cloud formation over the target area particularly on the first day, Tuesday, May 21st when rapid cloud build up forced termination of the flight after an initial calibration and before much useful data could be obtained. Meteorological conditions improved gradually from Tuesday May 21st to Friday May 24th with the best conditions on Thursday and Friday afternoons (flights 3, 4, 5 and 6). The flight patterns and pollutant profiles are shown in Figures 2, 3, 4 and 5 of the report.

As a rule the procedure followed in accomplishing each flight or mission was to obtain a vertical temperature profile of the atmosphere by monitoring ambient air temperature at regular intervals during a spiral ascent over Riverside Airport. The operational altitude for the survey was chosen on the basis of the temperature inversions indicated by these data and by visual observations of haze layer altitudes. In general the aircraft altitude was significantly higher than the inversion altitude. A spectrometer calibration was then performed before commencing a data run over the first leg of the pattern.

This consisted of zeroing the spectrometer output against the overhead sky and then recording the response obtained by temporarily inserting a standard reference cell in the optical path of the instrument. A similar calibration was performed frequently during the mission generally at the beginning and/or end of each leg of the flight patterns. At the completion of the mission temperatures were again measured at regular intervals during the descent to Riverside. These temperature profiles together with barometric pressure readings obtained on the ground prior to takeoff were later used to reduce the spectrometer strip chart recordings to average pollutant concentrations. The temperature readings were obtained from the aircraft thermometer which has a scale resolution of 1°C.

A summary of the flights and meteorological conditions is presented in Table 1.

3. DATA REDUCTION

The following basic data were used to reduce the spectrometer readings to gas concentration in parts per hundred million by volume:

(1) Spectrometer readings in the form of continuous graphical recordings of spectrometer output and periodic calibration signals.

(2) Aircraft ground track from a ground track recovery camera and visual observations.

(3) Barometric pressure at ground levels from altimeter settings, prior to take off.

(4) Temperature profiles in the vertical plane.

(5) Ground elevation along the ground track from topographical maps.

(6) Sun zenith angles as a function of time over the duration of the mission.

(7) Visual observations recorded during flight.

Refer to Chart 1 showing the results of Flight 2 for NO_2. The profile shown uses the ground track as a base line and was taken directly from the spectrometer strip chart. It represents the instantaneous total burden (integrated)

concentration pathlength product) of NO_2 as seen by the instrument and is in units of parts per million meters. To reduce ppm-meters to the average concentration in ppm it is necessary to determine the net effective pathlength or thickness of pollutant through which the light has passed before reaching the instrument. The first step in this procedure is to determine the thickness of the gas layer below the aircraft from a knowledge of the elevation of the ground and the measured or observed height of pollutant layer. For the purposes of this program the ground elevations were obtained from topographical maps of the Los Angeles area. To simplify the analysis the data run was divided into zones (shown on Flight 2 as I, II, III, IV and V), and a mean ground elevation determined for each zone. The data applicable to each zone is shown in Table 2. The top of the mixing layer was obtained from the inversion height of 6,500 feet recorded on the temperature surrounding shown on Table 2 and the difference between the inversion height and the average ground elevation taken as the mixing depth.

The concentration may therefore be determined from the relation:

$$\text{concentration (ppm)} = \frac{\text{instrument rdg. (ppm-meters)}}{\text{layer thickness x M factor}} \times \frac{1}{k_{av.}}$$

The M factor takes into account the fact that radiation components reaching the instrument come from all parts of a radiant sky as well as directly from the sun and is fully explained in Appendix I. The $\frac{1}{k_{av}}$ factor takes into account the variations of atmospheric temperature and pressure in the pollutant layer and is fully explained in Appendix II. Referring again to Table 2, the data listed as INSTR. RDG. is the average reading obtained by graphically integrating the profile in each zone. The data listed as SUN ANGLE are the solar zenith angles corresponding the mean time of each zone* and were used to obtain the M FACTOR from Appendix I. APP GAS is the apparent total gas burden in a vertical column below the aircraft. This is then modified by the $\frac{1}{k_{av}}$ function to arrive at the actual total gas burden in ppm-meters. Dividing through by the mixing depth in meters results in the concentration in ppm. Since only

* Altitude and Azimuth of the Sun for Latitude +34-00, Longitude +118-00, Nautical Almanac Office, U.S. Naval Observatory, Washington, D.C.

mean values of all variables in each zone are used in the reduction, it is useful to consider the profile as a simple concentration profile with a scale equivalent to the average concentration for each zone divided by the mean height of the profile. Concentration in pphm may then be read at any point on the profile using the scale of pphm/cm. This procedure of reduction is identical for all zones and missions. discussed herein.

4. DISCUSSION OF RESULTS

Flight 1/NO_2 Chart I - This mission was terminated before any useful data could be obtained because of very heavy cloud cover over the entire area east of Chino.

Flight 2/NO_2 May 22/68 Chart I - In spite of scattered cloud over parts of the route and heavy cloud cover over the central region of the Los Angeles Basin much useful data were obtained along the northern leg of the pattern. Also shown on Chart I are the meteorological and A.P.C.D. stations showing wind direction and magnitude and ground level pollutant measurements.

It should be borne in mind when comparing airborne results with ground readings that the two types of measurements are vastly different. The A.P.C.D. results are hourly averages obtained at a single point on the ground whereas the airborne result is an instantaneous reading of concentration averaged over the entire pollutant layer. The airborne result can be higher or lower than the ground measurement depending on the relative position of the ground monitor and the primary sources of pollution and the spatial distribution of pollutants in the atmosphere.

In general of course pollutants concentrations can be expected to be higher near the ground and near the sources of emission before they diffuse into the lower levels of the atmosphere or are dispersed by prevailing winds.

In spite of these major differences in the two methods some useful comparisons can be made. Referring again to Chart I, airborne values are shown at selected points along the profile indicated by the symbol Δ. These are points where the ground track and the prevailing wind permit most meaningful comparisons of airborne and ground measurements. The most significant fact in these data is the trend of values from Riverside to the Chatsworth Reservoir. Whereas the A.P.C.D. results increase from 0 to 7 pphm, the airborne results increase from 0.8 pphm to 2.5 pphm. Unfortunately heavy overcast prevented completion of the data run over Los Angeles center and attempts to fly under the overcast resulted in severe turbulence. The substantial quantities of NO_2 measured off the coast near Hawthorne can be attributed to pollution being carried out over the water by the wind. Note also on this Leg 3 of the flight that the western half of the leg is relatively free from pollution since this zone is downwind of rural areas.

Flight 3/SO_2 Chart II - Heavy cloud formation again limited the survey. Substantial levels of SO_2 were recorded with maximum values in the San Fernando Valley, Los Angeles center and north of Long Beach.

Flight 4/NO_2 Chart III - Interesting features of this profile are the rapid build up of NO_2 at Long Beach and the increase in pollutant over Riverside between the start of the survey at 16:44 and the end of the mission at 17:38. The increase is probably due to the transport of NO_2 from the Monrovia area to Riverside by the northwest wind.

Flight 5/SO_2 Chart IV - Surprisingly high levels of SO_2 were recorded with maximum levels obtained downwind of Los Angeles center in the Monterey Park area.

Flight 6/NO_2 Chart V - The excellent repeatability of the NO_2 measurement is demonstrated by three consecutive runs over the north-south leg. Of particular significance is the repeatable rapid build-up of NO_2 inside the Long Beach breakwater and the gradual build-up of NO_2 from the Santa Monica coastline to San Gabriel.

5. COMPARISON OF AIRCRAFT WITH SURFACE DATA

During the course of the flights, the amount of NO_2 as measured in the surface air varied from zero to 10 pphm, as measured by the Los Angeles Air Pollution Control District (L.A. A.P.C.D.). The corresponding concentration of SO_2 was between 1 and 2 pphm.

The times the aircraft overflew various L.A.A.P.C.D. stations are listed in Table 19 together with the relevant NO_2 concentrations measured by the A.P.C.D. In the last column of the table 18 is given the average concentration in the air below the aircraft as measured by the correlation spectrometer.

The results tabulated in the last two columns of Table 18 are plotted out in Figure 1.

A complete analysis of this data is not possible without a full knowledge of the vertical distribution of atmospheric NO_2. The concentration of pollutant usually falls off with height and therefore we expect the average concentration to be less than the surface concentration. Figure 1 shows how the average concentration was about one third of the surface value.

6. CONCLUSIONS

The airborne survey in the Los Angeles Basin conducted with the Barringer Correlation Spectrometer clearly demonstrates the capability of the equipment as a reliable tool for the synoptic survey of the distribution of total atmospheric pollution of NO_2 or SO_2 and for the measurement of atmospheric diffusion parameters.

During the survey the significantly large variation of NO_2 made it possible to compare average atmospheric pollution with that recorded at the ground truth stations operated by the Los Angeles Air Pollution Control District. The correlation between these two independent methods of measurement was good, bearing in mind normal meteorological variability.

The airborne equipment operated in a reliable manner during the survey and the ferry period to and from Toronto.

PREPARED BY:

A. J. Moffat, Project Engineer

APPROVED BY:

J. MacDowall

J. MacDowall, General Manager, Research and Development Division

AJM:jmb
September 24, 1968

SUMMARY OF FLIGHTS

TABLE 1

DATE	FLT. NO.	GAS	LINE NO.	TIME UP P.S.T.	TIME DOWN P.S.T.	REMARKS
21/5	1	NO_2	1	11:45	13:10	To Chino Airfield, Flt. aborted. Heavy Cu. coverage whole area. Return Riv. Calibration over Riv.
22/5	2	NO_2	1	07:30	9:34	To Chatsworth Reservoir Broken Cu. enroute.
	2		2			To Santa Monica Coast
	2		3			To South Side L.A. Airport. Sewage Pipe No. II.
	2		4			Sewage Pipe No. II to Hawthorne to Downy N.D.B. Divert to Long Beach Broken to overcast heavy Cu. tops at 5500 feet.
	2		6			Descended to 2500 ft. Leg aborted due to heavy Cu. at tops at 9500 ft. Unable to maintain VFR conditions
23/5	3	SO_2	1			Broken Cu. conditions
	3		2	11:02	13:37	Clear
	3		3			Clear
	3		4			Scattered to broken Cu.
	3		5			Scattered to broken Cu.
	3		6			Scattered to broken Cu. Tops at 6500 ft.

TABLE 1 (cont'd)

DATE	FLT. NO.	GAS	LINE NO.	TIME UP P.S.T.	TIME DOWN P.S.T.	REMARKS
23/5	4	NO_2	4&5 comb.	15:30	17:00	To Chino-Pimona Vortac. Radial 200° heading 220° to Long Beach Harbor. Broken to overcast Cu. Over other areas - also over Santa Ana.
	4		6			Long Beach to Anaheim.
24/5	5	SO_2	7	10:25	13:30	(3) Long Beach to Griffith Park (2) Griffith Park to Long Beach Scattered Cu.
	5		8			(2) Santa Monica to Monterey Park area (1) Monterey Park area to Santa Monica Broken Cu. at Monterey
24/5	6	NO_2	7	15:30	18:00	(2) Long Beach to Griffith Park (1) Griffith Park to Long Beach
	6		8			(1) Santa Monica to Monterey Park area (1) Monterey Park area to Santa Monica Very poor visibility due to flying into sun

DATA REDUCTION

LOCATION	Los Angeles					
DATE	May 22, 1968					
FLIGHT NUMBER	2					
INVERSION HEIGHT	6,500 Feet					
POLLUTANT	NO_2					
ZONE		I	II	III	IV	V
TIME P.S.T.	START-STOP	7.50-7.54	7.59-8.06	8.06-8.16	8.20-8.25	8.32-8.37
GROUND ELEVATION	FEET	710	750	775	1100	0
MIXING DEPTH	FEET	5790	5750	5725	5400	6500
INSTR. RDG.	PPM-M	40	59	69	39	19
SUN ANGLE	DEGREES	54	52	50	48	45
M FACTOR		2.76	2.70	2.65	2.61	2.55
APP. GAS	PPM-M	14.5	21.8	26.0	14.9	7.45
$1/K_{av.}$		1.06	1.06	1.06	1.06	1.06
ACTUAL GAS	PPM-M	15.4	23.1	27.6	15.8	7.9
CONCENTRATION	PPHM	0.87	1.32	1.57	0.96	0.40
SCALE	PPHM/CM.	0.87	0.89	0.91	0.98	0.83

TABLE 2

TABLE 3

TEMPERATURE SOUNDINGS - FLIGHT NO. 2, NO_2

DATE	TIME(P.S.T.)	TEMP. °C	ALTITUDE-FT.	AVERAGE ASC/DESC TEMP °C
May 22	07:30	15	790 (on ground)	15.5
		13	1000	13
		12	1500	13
		10	2000	11
		9	3000	9.5
		6	4000	7
		4	5000	5
		4	6000	4
		5	6500	4.5
	07:50	4	6640	
May 22	9:23	6	7000	
		4	6500 - Inversion	
		4	6000	
		5	5500	
		6	5000	
		8	4000 ← Cloud Layer	
		9	3500	
		10	3000	
		11	2500	
		12	2000	
		14	1500	
	9:34	16	Ground, 21° still air	

AND CORRECTION FACTOR CALCULATION

LOCATION: L.A. RIVERSIDE FLIGHT NO. 2

DATE: May 22

TIME OF TAKE OFF/LAND		ASCENT 07:30 P.S.T.	DESCENT 9:34 P.S.T.
AIRPORT GRD PRESS	in Hg.	29.91"	
" " TEMP (on taxi)	°C	15°C	
" WIND (GROUND)	mph deg	2 mph @ 260° Magnetic	
" " (ALOFT)	knots deg		

(A) HEIGHT m.s.l. ± 100 FT.	(E) TEMPERATURE °C	°A	(F) T/293°A ± .005	(B) PRESS. ± 5 mb.	(C) THICK t ± 5 mb	(D) REL. PRESS. ± .005	(G) (D)(F) k ± .005	(H) (C)(G) kt ± .1mb
790	15.5			1010				
790-1000		287	.980		5	.99	1.01	5.0
1000	13			1005				
1000-1500		286	.975		20	.98	1.00	20.0
1500	13			985				
1500-2000		285	.970		20	.96	.99	19.8
2000	11			965				
2000-3000		283	.965		35	.94	.97	34.0
3000	9.5			930				
3000-4000		281	.960		30	.90	.94	28.2
4000	7			900				
4000-5000		279	.950		30	.87	.92	27.6
5000	5			870				
5000-6000		277.5	.945		35	.84	.89	31.2
6000	4			835				
6000-6500		277	.945		15	.82	.87	13.1
6500	4.5			820				

NOTE: TEMPERATURE DATA FROM AVERAGE OF ASCENT/DESCENT

$\Sigma t = 190$

$\Sigma kt = 178.9$

$K_{AV} = .94$

$\frac{1}{K_{av}} = 1.06$

DATA REDUCTION

LOCATION		Los Angeles				
DATE		May 23, 1968				
FLIGHT NUMBER		3				
INVERSION HEIGHT		5,000 Feet				
POLLUTANT		SO_2				
ZONE		I	II	III	IV	V
TIME P.S.T.	START-STOP	1129-1133	1142-1147	1147-1151	1155-1201	1223-1229
GROUND ELEVATION	FEET	980	1320	875	1100	62
MIXING DEPTH	FEET	4020	3680	4125	3900	4938
INSTR. RDG.	PPM-M	61	63	80	40	53
SUN ANGLE	DEGREES	16	15	14.5	14	16
M FACTOR		2.47	2.46	2.43	2.50	2.49
APP. GAS	PPM-M	24.7	25.6	33.0	16.0	21.3
$1/K_{av.}$		1.04	1.04	1.04	1.05	1.05
ACTUAL GAS	PPM-M	25.9	26.6	34.3	16.8	22.4
CONCENTRATION	PPHM	2.11	2.37	2.73	1.41	1.49
SCALE	PPHM/CM.	1.39	1.50	1.36	1.41	1.13

TABLE 5

LOCATION	Los Angeles
DATE	May 23, 1968
FLIGHT NUMBER	3 cont.
INVERSION HEIGHT	5,000 feet
POLLUTANT	SO_2

NOTE: $\frac{1}{k_{av}}$ from ascent used for Zones II & III

$\frac{1}{k_{av}}$ from average profile used for Zones IV,V & VI

$\frac{1}{k_{av}}$ from descent profile used for Zones VII,VIII & IX

ZONE		VI	VII	VIII	IX	
TIME P.S.T.	START-STOP	1251-1255	1302-1311	1311-1317	1317-1321	
GROUND ELEVATION	FEET	25	35	300	635	
MIXING DEPTH	FEET	4975	4965	4700	4365	
INSTR. RDG.	PPM-M	71	48	30	30	
SUN ANGLE	DEGREES	20	22	24	25	
M FACTOR		2.48	2.53	2.57	2.61	
APP. GAS	PPM-M	28.7	19.0	11.7	11.5	
1/Kav.		1.05	1.06	1.06	1.06	
ACTUAL GAS	PPM-M	30.4	20.1	12.4	12.2	
CONCENTRATION	PPHM	2.00	1.32	0.86	0.92	
SCALE	PPHM/CM.	1.12	1.10	1.15	1.23	

TABLE NO. 6

TEMPERATURE SOUNDING - FLIGHT NO. 3, SO_2

DATE	TIME (P.S.T.)	TEMP.°C	ALTITUDE, FT.	AVERAGE ASC/DESC TEMP °C
		(17)	790 (on ground)	(18.5)
May 23	11:04	15	1500	16.5
		13	2000	15
		12	2500	14
		10	3000	12
		9	3500	11.5
		8	4000	9
		6	5000	7 - Inversion
		6	6000	8
	11:14	7-9	7000	8

( ) = estimated value

May 23	13:27	8	7000
		10	6000
		7	5500
		8	5000
		10	4000
		12	3500
		14	3000
		16	2500
		17	2000
	13:37	18	1500
		(20)	790 (on ground)

TABLE NO. 7

TEMP/PRESS PROFILE CHART
AND CORRECTION FACTOR CALCULATION

LOCATION: LOS ANGELES RIVERSIDE

FLIGHT NO. 3, SO_2

DATE: May 23, 1968

TIME OF TAKE OFF/LAND		ASCENT 11:02 P.S.T.	DESCENT 13:37 P.S.T.
AIRPORT GRD PRESS	in Hg.	29.94"	
" " TEMP (on taxi)	°C	15°C	
" WIND (GROUND)	mph deg	10 mph @ 280°	
" " (ALOFT)	knots deg		

(A) HEIGHT m.s.l. ± 100 FT.	(E) TEMPERATURE °C	°A	(F) T / 293°A ± .005	(B) PRESS. ± 5 mb.	(C) THICK t ± 5 mb	(D) REL. PRESS. ± .005	(G) D/F k ± .005	(H) C G kt ± .1mb
790	17			1010				
790-1500		289	.986		25	.984	.999	25
1500	15			985				
1500-2000		287	.980		15	.965	.985	14.8
2000	13			970				
2000-2500		285.5	.974		17	.948	.974	16.6
2500	12			953				
2500-3000		284	.969		18	.931	.962	13.3
3000	10			935				
3000-3500		282.5	.964		15	.915	.950	14.3
3500	9			920				
3500-4000		281.5	.960		15	.900	.937	14.1
4000	8			905				
4000-5000		280	.955		35	.877	.919	32.2
5000	6			870				

NOTE: TEMPERATURE DATA FROM ASCENT

Σt = 140 mb

Σkt = 134.3 mb

$K_{AV} = .96$

$\frac{1}{K_{av}} = 1.04$

TABLE No. 8

TEMP/PRESS PROFILE CHART
AND CORRECTION FACTOR CALCULATION

LOCATION: LOS ANGELES RIVERSIDE

FLIGHT NO. 3, SO_2.

DATE: May 23, 1968

TIME OF TAKE OFF/LAND		ASCENT 11:02 P.S.T.	DESCENT 13:37 P.S.T.
AIRPORT GRD PRESS	in Hg.	29.94"	
" " TEMP (on taxi)	°C	15°C	
" WIND (GROUND)	mph deg	10 mph @ 280°	
" " (ALOFT)	knots deg		

(A) HEIGHT m.s.l. ± 100 FT.	(E) TEMPERATURE °C	°A	(F) $\frac{T}{293°A}$ ± .005	(B) PRESS. ± 5 mb.	(C) THICK t ± 5 mb	(D) REL. PRESS. ± .005	(G) $\sqrt{(D)(F)}$ k ± .005	(H) (C)(G) kt ± .1mb
790	18.5			1010				
790-1500		290.5	.991		25	.984	.993	24.8
1500	16.5			985				
1500-2000		288.7	.987		15	.965	.977	14.6
2000	15			970				
2000-2500		287.5	.980		17	.948	.969	16.5
2500	14			953				
2500-3000		286	.976		18	.931	.954	17.2
3000	12			935				
3000-3500		284.7	.972		15	.915	.941	14.1
3500	11.5			920				
3500-4000		283.2	.965		15	.900	.933	14.0
4000	9			905				
4000-5000		281	.959		35	.877	.915	32.0
5000	7			870				

NOTE: TEMPERATURE DATA FROM AVERAGE OF ASCENT/DESCENT

Σt = 140 mb

Σkt = 133.2 mb

K_{AV} = .95

$\frac{1}{K_{av}}$ = 1.05

TABLE NO. 9

TEMP/PRESS PROFILE CHART
AND CORRECTION FACTOR CALCULATION

LOCATION: LOS ANGELES RIVERSIDE FLIGHT NO. 3, SO_2

DATE: May 23, 1968

TIME OF TAKE OFF/LAND		ASCENT 11:02 P.S.T.	DESCENT 13:37 P.S.T.
AIRPORT GRD PRESS	in Hg.	29-94"	
" " TEMP (on taxi)	°C	15°C	
" WIND (GROUND)	mph deg	10 mph @ 280°	
" " (ALOFT)	knots deg		

(A) HEIGHT m.s.l. ± 100 FT.	(E) TEMPERATURE °C	°A	(F) T/293°A ± .005	(B) PRESS. ± 5 mb.	(C) THICK t ± 5 mb	(D) REL. PRESS. ± .005	(G) (D)(F) k ± .005	(H) (C)(G) kt ± .1mb
790	20			1010				
790-1500		292	.996		25	.984	.988	24.7
1500	18			985				
1500-2000		290.5	.991		15	.965	.974	14.6
2000	17			970				
2000-2500		289.5	.988		17	.948	.960	16.3
2500	16			953				
2500-3000		288	.982		18	.931	.949	17.1
3000	14			935				
3000-3500		286	.976		15	.915	.937	14.1
3500	12			920				
3500-4000		284	.969		15	.900	.930	14.0
4000	10			905				
4000-5000		282	.962		35	.877	.911	31.9
5000	8			870				

NOTE: TEMPERATURE DATA FROM DESCENT

$\Sigma t = 140$

$\Sigma kt = 132.7$

$K_{AV} = .946$

$\frac{1}{K_{av}} = 1.06$

DATA REDUCTION

LOCATION		Los Angeles				
DATE		May 23, 1968				
FLIGHT NUMBER		4				
INVERSION HEIGHT		4,800 Feet				
POLLUTANT		NO_2				
ZONE		I	II	III	IV	V.
TIME P.S.T.	START-STOP	1544-1552	1552-1600	1604-1606	1606-1609	1609-1612
GROUND ELEVATION	FEET	650	800	700	450	275
MIXING DEPTH	FEET	4150	4000	4100	4350	4525
INSTR. RDG.	PPM-M	18	60	65	63	80
SUN ANGLE	DEGREES	54	56	58	58	59
M FACTOR		2.76	2.81	2.88	2.88	2.91
APP. GAS	PPM-M	6.5	21.4	22.6	21.8	27.5
$1/K_{av.}$		1.05	1.05	1.05	1.05	1.05
ACTUAL GAS	PPM-M	6.8	22.5	23.7	22.9	28.9
CONCENTRATION	PPHM	.54	1.85	1.90	1.73	2.10
SCALE	PPHM/CM.	1.20	1.23	1.17	1.10	1.05

TABLE 10

DATA REDUCTION

LOCATION		Los Angeles				
DATE		May 23, 1968				
FLIGHT NUMBER		4 cont.				
INVERSION HEIGHT		4,800 Feet				
POLLUTANT		NO_2				
ZONE		VI	VII	VIII	IX	X
TIME P.S.T.	START-STOP	1612-1618	1626-1634	1634-1636	1636-1639	6139-1642
GROUND ELEVATION	FEET	75	50	150	340	635
MIXING DEPTH	FEET	4725	4750	4650	4460	4165
INSTR. RDG.	PPM-M	45	100	73	59	45
SUN ANGLE	DEGREES	60	63	64	64.5	65
M FACTOR		2.96	3.08	3.13	3.13	3.25
APP. GAS	PPM-M	15.2	32.5	23.4	18.9	13.9
1/Kav.		1.05	1.05	1.05	1.05	1.05
ACTUAL GAS	PPM-M	16.0	34.1	24.6	19.8	14.6
CONCENTRATION	PPHM	1.11	2.35	1.74	1.45	1.15
SCALE	PPHM/CM.	0.99	0.94	0.95	0.98	1.03

TABLE 10 (CONTINUED)

TABLE 11

TEMPERATURE SOUNDING - FLIGHT NO. 4, NO_2

DATE	TIME (P.S.T.)	TEMP. °C	ALTITUDE, FT.	AVERAGE ASC/DESC TEMP °C
May 23	15:30	22	790 (on ground)	22
		20	1000	19
		18	1500	17.5
		16	2000	16
		14	2500	14
		13	3000	13
		12	3500	12.5
		10.5	4000	10.8
		10	5000	10
		9	6000	9.2
		8	7000	8
	15:44	6	8000	

DATE	TIME (P.S.T.)	TEMP. °C	ALTITUDE, FT.	
May 23	16:46	8	7500	
		8	7000	
		9	6500	
		9.5	6000	
		10	5500	
		10	5000	
		10	4500 4800 Inversion	
		11	4000	
		13	3500	
		13	3000	
		14	2500	
		16	2000	
		17	1500	
	16:58	18	1000	

TABLE NO. 12

TEMP/PRESS PROFILE CHART
AND CORRECTION FACTOR CALCULATION

LOCATION: LOS ANGELES RIVERSIDE

DATE: May 23, 1968

FLIGHT NO. 4, NO_2

TIME OF TAKE OFF/LAND		ASCENT 15:30 P.S.T.	DESCENT 17:00 P.S.T
AIRPORT GRD PRESS	in Hg.	29.88"	
" " TEMP (on taxi)	°C	24°C	
" WIND (GROUND)	mph deg	25 mph @ 250°	
" " (ALOFT)	knots deg		

(A) HEIGHT m.s.l. ± 100 FT.	(E) TEMPERATURE °C	TEMPERATURE °A	(F) T / 293°A ± .005	(B) PRESS. ± 5 mb.	(C) THICK t ± 5 mb	(D) REL. PRESS. ± .005	(G) D ÷ F k ± .005	(H) C G kt ± .1mb
790	22			1010				
790-1500		291.7	.994		25	.984	.990	24.8
1500	17.5			985				
1500-2000		289.7	.987		15	.965	.978	14.7
2000	16			970				
2000-2500		288	.983		17	.948	.965	16.4
2500	14			953				
2500-3000		286.5	.978		18	.931	.952	17.2
3000	13			935				
3000-3500		285.7	.974		15	.915	.940	14.1
3500	12.5			920				
3500-4000		284.6	.971		15	.900	.927	13.9
4000	10.8			905				
4000-4800		283.4	.966		30	.879	.910	27.3
4800	10			875				

$\Sigma t = 13.5$

$\Sigma kt = 128.4$

$K_{AV} = 0.95$

$\frac{1}{K_{av}} = 1.05$

DATA REDUCTION

LOCATION	Los Angeles
DATE	May 24, 1968
FLIGHT NUMBER	5
INVERSION HEIGHT	4000 Feet
POLLUTANT	SO_2

ZONE		I	II	III		
TIME	START-STOP	1103-1105	1105-1111	1234-1243		
GROUND ELEVATION	FEET	400	100	200		
MIXING DEPTH	FEET	3600	3900	3800		
INSTR. RDG.	PPM-M	75	80	100		
SUN ANGLE	DEGREES	18	16.5	16.5		
M FACTOR		2.46	2.44	2.42		
APP. GAS	PPM-M	30.5	32.8	41.3		
$1/K_{av.}$		1.04	1.04	1.04		
ACTUAL GAS	PPM-M	31.5	36.2	45.6		
CONCENTRATION	PPHM	2.90	3.04	3.94		
SCALE	PPHM/CM.	1.55	1.52	1.58		

TABLE 13

TABLE 14

TEMPERATURE SOUNDING - FLIGHT NO. 5, SO_2

DATE	TIME (P.S.T.)	TEMP. °C	ALTITUDE, FT.	AVERAGE ASC/DESC TEMP °C
May 24	10:23	22	790 (on ground)	22
		18	1000 straight climb to coast	19.5
		16	1500	18
		14	2000	16
		12	2500	14.5
		11	3000	13.5
		10	3500	12
		10	4000 - INVERSION	12
		11	5000	11
		10	6500	10
		10	7000	10
	10:32	9	8000	9

DATE	TIME (P.S.T.)	TEMP. °C	ALTITUDE, FT.	AVERAGE ASC/DESC TEMP °C
May 24	13:20	13	4500	
		14	4000	
		14	3500	
		16	3000	
		17	2500	
		18	2000	
		20	1500	
	13:28	21	1000	

TABLE 15

TEMP/PRESS PROFILE CHART
AND CORRECTION FACTOR CALCULATION

LOCATION: RIVERSIDE MUNICIPAL FLIGHT NO. 5, SO_2

DATE: May 24, 1968

TIME OF TAKE OFF/LAND		
AIRPORT GRD PRESS	in Hg.	30.00
" " TEMP (on taxi)	°C	22°C
" WIND (GROUND)	mph deg	5 mph @ 270°
" " (ALOFT)	knots deg	

(A) HEIGHT m.s.l. ± 100 FT.	(E) TEMPERATURE °C	TEMPERATURE °A	(F) $\frac{T}{293°A}$ ± .005	(B) PRESS. ± 5 mb.	(C) THICK t ± 5 mb	(D) REL. PRESS. ± .005	(G) $\frac{D}{F}$ k ± .005	(H) C G kt ± .1mb
0								
790	22	(GROUND ELEV.)		1016				
790-1500		293	1.000		23	.992	.992	22.8
1500	18			993				
1500-2000		290	.990		20	.970	.980	19.6
2000	16			973				
2000-2500		288.2	.982		17	.951	.970	16.5
2500	14.5			956				
2500-3000		287	.978		17	.934	.955	16.2
3000	13.5			939				
3000-3500		285.7	.973		17	.916	.941	16.0
3500	12			923				
3500-4000		285	.972		16	.900	.926	14.8
4000	12			906				

Σt = 110

Σkt = 105.9

K_{AV} = .962

$\frac{1}{K_{av}}$ = 1.04

DATA REDUCTION

LOCATION	Los Angeles
DATE	May 24, 1968
FLIGHT NUMBER	6
INVERSION HEIGHT	3,000 Feet
POLLUTANT	NO_2

ZONE		I	II	III	IV	
TIME	START-STOP	1633-1647	1558-1610	1614-1625	1703-1710	
GROUND ELEVATION	FEET	160	160	160	200	
MIXING DEPTH	FEET	2840	2840	2840	2800	
INSTR. RDG.	PPM-M	65	80	80	95	
SUN ANGLE	DEGREES	64.5	57	60.5	70	
M FACTOR		3.18	2.84	2.95	3.52	
APP. GAS	PPM-M	20.4	28.2	27.1	27.0	
$1/K_{av.}$		1.03	1.03	1.03	1.03	
ACTUAL GAS	PPM-M	21.0	29.1	27.9	27.8	
CONCENTRATION	PPHM	2.42	3.36	3.22	3.26	
SCALE	PPHM/CM.	1.49	1.68	1.61	1.37	

TABLE 16

TABLE 17

TEMPERATURE SOUNDING - FLIGHT NO. 6, NO_2

DATE	TIME (P.S.T.)	TEMP. °C	ALTITUDE, FT.	AVERAGE ASC/DESC TEMP. °C
May 24	15:30	26, still	790 (on ground)	
		22	1000	
		20	1500	
		20	2000-3000, heavy air traffic	
		17	3500	
		16	4000	
		15	4500	
		13	5000	
		12	6000	
		10	7500	
		8	8000	
		7	10,000	
	15:58	6	10,300	
	17:40	7	10,000	(7)
		8	9500	(8)
		9	9000	
		10	8500	
		10	8000	9
		12	7000	
		13	6000	12.5
		14	5500	
		15	4500	15
		17	4000	16.5
		18	3500	17.5
		16	3000 - INVERSION	16 - INVERSION
		17	2500	17
		17	2000	17
		18	1500	19
	18:00	18	1000	20
		20	790 (on ground)	23

( ) = estimated value

TEMP/PRESS PROFILE CHART
AND CORRECTION FACTOR CALCULATION

LOCATION: RIVERSIDE MUNICIPAL FLIGHT NO. 6, NO_2

DATE: May 24, 1968

TIME OF TAKE OFF/LAND		ASCENT 15:30 P.S.T.	DESCENT 18:00 P.S.T.
AIRPORT GRD PRESS	in Hg.	29.96	
" " TEMP (on taxi)	°C		
" WIND (GROUND)	mph deg		
" " (ALOFT)	knots deg		

(A) HEIGHT m.s.l. ± 100 FT.	(E) TEMPERATURE °C	°A	(F) $\frac{T}{293°A}$ ± .005	(B) PRESS. ± 5 mb.	(C) THICK t ± 5 mb	(D) REL. PRESS. ± .005	(G) $\frac{D}{F}$ k ± .005	(H) (C)(G) kt ± .1mb
0								
790	23 (on ground)			1016				
790-1500		294	1.00		23	.992	.992	22.8
1500	19			993				
1500-2000		291	.993		20	.970	.977	19.5
2000	17			973				
2000-2500		290	.990		17	.951	.960	16.3
2500	17			956				
2500-3000		289.5	.988		17	.934	.944	16.1
3000	16			939				

$\Sigma t = 77$

$\Sigma kt = 74.7$

$K_{AV} = .97$

$\frac{1}{K_{av}} = 1.03$

TABLE 19 - COMPARISON BETWEEN AIRCRAFT AND GROUND NO_2 DATA

May 22, 1968

TIME (P.S.T.)	STATION	A.P.C.D. POLLUTION AT SURFACE (pphm)	BARRINGER AVERAGE POLLUTION (pphm)
7.52	Chino	0	0.8
7.59	73	2	0.4
8.02	60	1	1.1
8.05	64	4	2.1
8.11	69	6	1.3
8.15	74	7	2.5

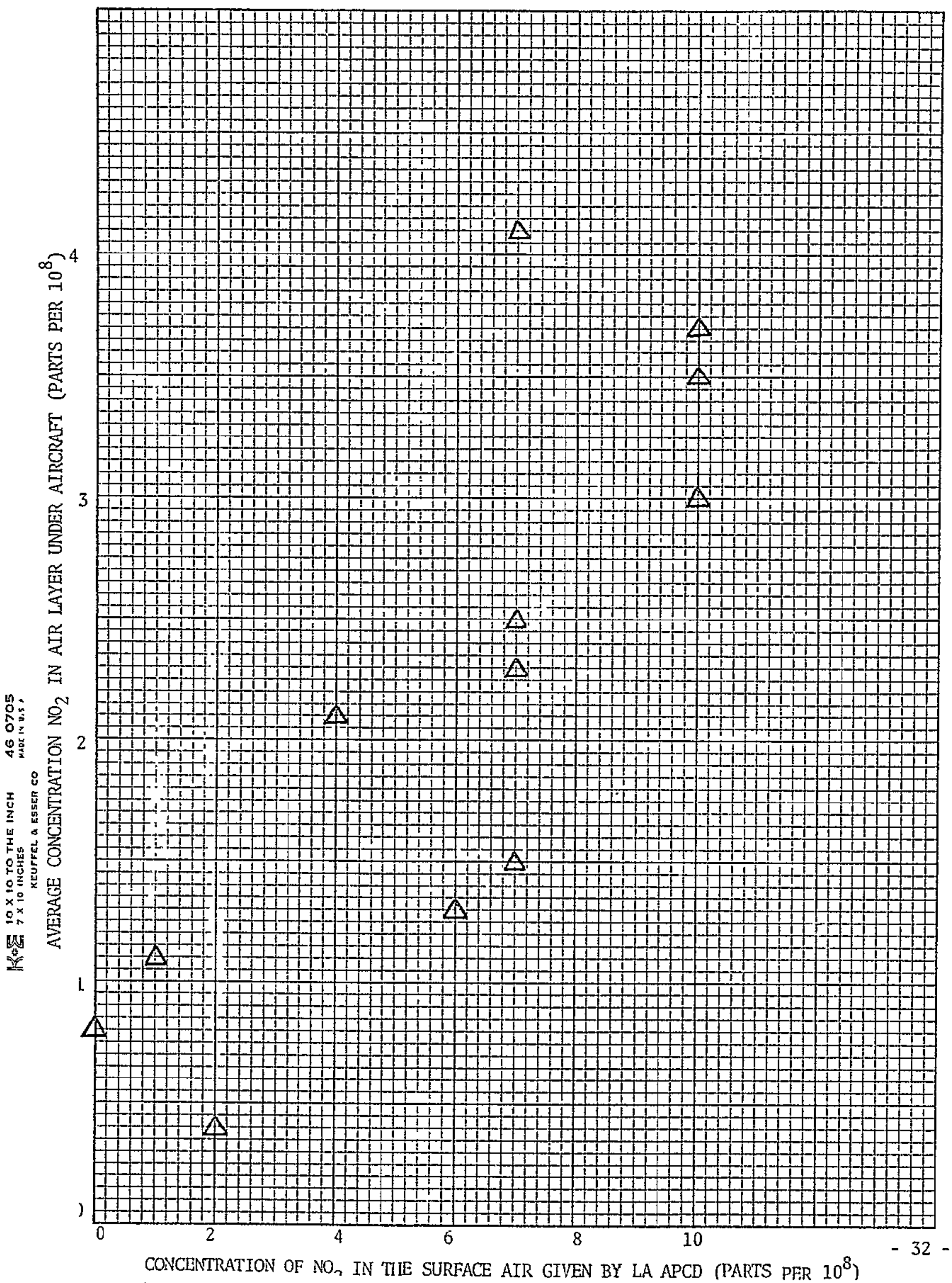
May 23, 1968

TIME (P.S.T.)	STATION	A.P.C.D. POLLUTION AT SURFACE (pphm)	BARRINGER AVERAGE POLLUTION (pphm)
15.56	75	7	2.5
16.14	72	7	1.5
16.30	72	7	2.3

May 24, 1968

TIME (P.S.T.)	STATION	A.P.C.D. POLLUTION AT SURFACE (pphm)	BARRINGER AVERAGE POLLUTION (pphm)
16.42	72	10	3.7
16.04	72	10	3.0
16.20	72	10	3.5
17.07	1	7	4.1

FIGURE 1 - COMPARISON BETWEEN AVERAGE POLLUTION AND SURFACE POLLUTION



APPENDIX A - DERIVATION OF PATHLENGTH FACTOR

1) RADIATION COMPONENTS

For a study concerned with the radiation arriving at an aircraft-placed spectrometer looking directly down, it is necessary to separate the radiation incident on the ground from a source point of view.

First, we consider the direct sun component, defined by its spectral irradiance in w cm^{-2} nm^{-1} for a given wavelength.
It will be denoted as H_λ, and in a general case we expect it to be a function $H_\lambda = H_\lambda(\theta,\tau,T,\psi)$ of the following parameters

θ	sun zenith angle
ψ	air mass
τ	ozone thickness
T	atmospheric turbidity

The spectral radiant power on the ground unit area P_λ in w nm^{-1} will be

$$P_\lambda' = H_\lambda \cos\theta \tag{1-1}$$

Considering a Lambertian reflection from the ground of reflecting $Rf(\lambda)$, the spectral radiance of the ground as observed from the aircraft-based instrument

is $$N_\lambda = \frac{Rf(\lambda)H\lambda\cos\theta}{\pi} \qquad \text{w cm}^{-2}\ \text{sr}^{-1}\ \text{nm}^{-1} \qquad (1\text{-}2$$

The second component, that of the radiation emerging from the atmosphere due to the scattering of the sunlight is

$$N_\lambda' = N_\lambda' \ [\theta,\tau,\psi,\ \phi,\gamma,Rf(\lambda)]$$

for a perfect Rayleigh atmosphere, where:

θ is the sun zenith angle

τ ozone thickness

ψ air mass

ϕ azimuth of emission area referred to a vertical plane passing through the local zenith and the sun zenith angle of emission area

γ

γ zenith angle on emission area

$Rf(\lambda)$ reflectivity of ground

For a real atmosphere and a given specific location and time, this component is more likely to be

$$N'_\lambda = N'_\lambda\ (\theta,\tau,\psi,\phi,\gamma,Rf(\lambda)T)$$

where T is the atmospheric turbidity, function of the aerosol content, size and distribution.

The spectral radiant power on the ground due to a differential area of the sky that is projected into the solid angle $\frac{1}{R_2}\cos\gamma$ [1 = unit area on the ground-cm^2 R = imaginary distance from sky area to the ground] by which the unit ground area is seen from the sky area, is:

$$P''_\lambda = N'_\lambda \cos\gamma\ \sin\gamma\ d\gamma\ d\phi \qquad \text{w nm}^{-1} \tag{1-3}$$

The spectral radiance of the ground unit area as observed from the aircraft and from this second component is

$$N''_\lambda = \frac{Rf(\lambda)}{\pi}\iint N'_\lambda \cos\gamma\ \sin\gamma\ d\gamma\ d\phi \qquad \text{w cm}^{-2}\ \text{sr}^{-1}\ \text{nm}^{-1} \tag{1-4}$$

for a fixed λ

The total energy arriving at the instrument is

$$P_\lambda = A\Omega \left[\int_{\lambda_1}^{\lambda'_1} N\lambda \, d\lambda + \int_{\lambda_1}^{\lambda'_1} N''_\lambda \, d\lambda \right] \quad \text{in watts} \qquad (1\text{-}5)$$

A = instrument aperture

Ω = instrument acceptance angle

$\lambda_1 - \lambda'_1$ = waveband of interest

where no absorption or scattering below the aircraft are considered.

2) CORRELATION SPECTROMETRY APPLICATION

In this section we are concerned with the absorption of the gas under study. Our assumptions are:

1st The absorption is done only by the gas

2nd There is no scattering below the aircraft

3rd All the gas is below the aircraft

4th The instrument optics are such that the response to all wavelengths within the interval of interest is linear-constant

For the general case of an airborne-based instrument looking vertically down, the center of the ground patch determined by its field of view is taken as the origin of coordinates.

The vertical axis is that of the local zenith, the azimuth angle (ϕ)is measured with reference to a plane passing through the vertical and the sun, and the angle γ is measured from the zenith.

The concentration of the absorbing gas for the line of sight S (ϕ,γ) is in the most general case a function $c = c(\phi,\gamma,\ell)$ (for a given period of time) of those angles and another independent variable (ℓ). Here the length along the line of sight is taken as such.

The beam of light proceeding from the fictitious zone in the sky of area $R^2 \sin\gamma d\gamma d\phi$ and spectral radiance N'_λ travels along the pathlength ℓ and is attenuated by

$$e^{-a(\lambda)\cdot\int_0^\ell c\,d\ell} \qquad \text{(for every wavelength)}$$

$a(\lambda)$ being the absorption corssection per molecule, function of wavelength

After a Lambertian reflection on the ground of reflectivity Rf (λ), it is attenuated by

$$e^{-a(\lambda)\int_0^h c_\ell \, dz}$$

on its way back to the aircraft.

c_ℓ corresponding to c(o, o, h) depends only on height (h).

The elemental energy in the instrument due to the beam travelling this path is:

$$dP = \frac{A\Omega}{\pi} \cdot Rf(\lambda)\, N'_\lambda \, e^{-a(\lambda)\left[\int_0^\ell c\, d\ell + \int_0^h c_1\, dz\right]} \sin\gamma \cos\gamma \, d\gamma \, d\varphi \, d\lambda \tag{2-1}$$

The energy in the instrument proceeding from the whole sky for one slit is

$$P = \frac{A\Omega}{\pi} \iiint Rf(\lambda)\, N'_\lambda \, e^{-a(\lambda)\left[\int_0^\ell c\, d\ell + \int_0^h c_1\, dz\right]} \cos\gamma \sin\gamma \, d\gamma \, d\varphi \, d\lambda \tag{2-2}$$

λ integrated for the limits defining the slit

The other component, that due to the direct sunlight following the same process, will be

$$dP_2 = \frac{A\Omega}{\pi} Rf(\lambda)\, H_\lambda \cos\theta \, e^{-a(\lambda)\left[\int_0^\ell c_2\, d\ell + \int_0^h c_1\, dz\right]} d\lambda$$

(2-3)

$$P_2 = \frac{A\Omega}{\pi} \int Rf(\lambda)\, H_\lambda \cos\theta \, e^{-a(\lambda)\left[\int_0^\ell c_2\, d\ell + \int_0^h c_1\, dz\right]} d\lambda$$

C_2 is the concentration along the line fo sight $S(0, \theta)$ corresponding to $c(0,\theta,\ell)$

The modulation at an aircraft-based instrument looking down will be

$$
M = \frac{A\Omega}{\pi} \left\{ \sum_{i=1}^{m} \Bigg[\iiint Rf(\lambda)\, N'_\lambda \exp\left[-a(\lambda)\left(\int_0^{\ell} c\,d\ell + \int_0^{h} c_1\,dz\right)\right] \cos\gamma \sin\gamma \, d\gamma\, d\varphi\, d\lambda + \int Rf(\lambda)\, H_\lambda \cos\theta \exp\left[-a(\lambda)\left(\int_0^{\ell} c_2\,d\ell + \int_0^{h} c_1\,dz\right)\right] d\lambda \Bigg]_{\lambda_{1i}}^{\lambda'_{1i}} - \sum_{i=1}^{m} \Bigg[\iiint Rf(\lambda)\, N'_\lambda \exp\left[-a(\lambda)\left(\int_0^{\ell} c\,d\ell + \int_0^{h} c_1\,dz\right)\right] \cos\gamma \sin\gamma \, d\varphi\, d\varphi\, d\lambda + \int Rf(\lambda)\, H_\lambda \cos\theta \exp\left[-a(\lambda)\left(\int_0^{\ell} c_2\,d\ell + \int_0^{h} c_1\,dz\right)\right] d\lambda \Bigg]_{\lambda_{2i}}^{\lambda'_{2i}} \right\} \frac{a}{o}
$$

$$
\left| \sum_{i=1}^{m} \Bigg[\iiint Rf(\lambda)\, N'_\lambda \exp\left[-a(\lambda)\left(\int_0^{\ell} c\,d\ell + \int_0^{h} c_1\,dz\right)\right] \cos\gamma \sin\gamma \, d\gamma\, d\varphi\, d\lambda + \int Rf(\lambda)\, H_\lambda \cos\theta \exp\left[-a(\lambda)\left(\int_0^{\ell} c_2\,d\ell + \int_0^{h} c_1\,dz\right)\right] d\lambda \Bigg]_{\lambda_{1i}}^{\lambda'_{1i}} \right| \tag{2-4}
$$

$$
\text{or} \quad M = \frac{\sum_{i=1}^{n} \left[P + P_2\right]_{\lambda_{1i}}^{\lambda'_{1i}} - \sum_{i=1}^{n} \left[P + P_2\right]_{\lambda_{2i}}^{\lambda'_{2i}}}{\left| \sum_{i=1}^{m} \left[P + P_2\right]_{\lambda_{1i}}^{\lambda'_{1i}} \right|} \tag{2-5}
$$

λ_{1i} - λ'_{1i} are the beginning and end wavelength of the mask corresponding to the slit (i) for the position (1) of the mask with respect to the spectrum.

$\lambda_{1i}' - \lambda_{2i}'$ The same for the next position (2) of the mask with respect to the spectrum.

n The number of slits in the mask.

The purpose of aircraft measurements is to obtain "as accurate as possible" measurement of c_1, that is, the concentration directly below the aircraft; this concentration cannot be calculated for the more general case.

In aircraft use, the zeroing is done against the vertical and the measurement, looking down. The reading R will be equal to

$$R = \alpha \left\{ \frac{\sum_{i=1}^{n} \int_{\lambda_{2i}}^{\lambda_{2i}'} (N_\lambda)_v \, d\lambda}{\sum_{i=1}^{n} \int_{\lambda_{1i}}^{\lambda_{1i}'} (N_\lambda')_v \, d\lambda} \right. - \qquad \mathrm{I}$$

$$\sum_{i=1}^{n} \left[\iiint R f(\lambda)\, N_\lambda' \exp\left[-a(\lambda)\left(\int_0^{l} c\, dl + \int_0^{h} c_1 dz\right)\right] \sin\gamma \cos\gamma \, d\gamma\, d\varphi\, d\lambda + \right.$$

$$\left. \int R f(\lambda)\, H_\lambda \cos\theta \, \exp\left[-a(\lambda)\left(\int_0^{l} c_2 dl + \int_0^{h} c_1 dz\right)\right] d\lambda \right]_{\lambda_{2i}}^{\lambda_{2i}'} \div$$

$$\sum_{i=1}^{n} \left[\iiint R f(\lambda)\, N_\lambda' \exp\left[-a(\lambda)\left(\int_0^{l} c\, dl + \int_0^{h} c_1 dz\right)\right] \sin\gamma \cos\gamma \, d\gamma\, d\varphi\, d\lambda + \right.$$

$$+ \int R f(\lambda)\, H_\lambda \cos\theta \exp\left[-a(\lambda)\left(\int_0^{\ell} c_2\, d\ell + \int_0^{h} c_1\, dz\right)\right] d\lambda \Bigg]_{\lambda_{1i}}^{\lambda'_{1i}} \quad \Bigg\}$$

II

(2-6)

$(N'_\lambda)v$ = spectral radiance of the vertical zone of the sky

α The instrument constant, combination of optics and electronics, transmission and response factors.

The instrument calibration is done against the vertical; therefore, the calibration values follow the expression

$$CR = \alpha \left\{ \underbrace{\frac{\sum_{i=1}^{n} \int_{\lambda_{2i}}^{\lambda'_{2i}} (N'_\lambda)_v \, d\lambda}{\sum_{i=1}^{n} \int_{\lambda_{1i}}^{\lambda'_{1i}} (N'_\lambda)_v \, d\lambda}}_{\text{III}} - \underbrace{\frac{\sum_{i=1}^{n} \int_{\lambda_{2i}}^{\lambda'_{2i}} (N'_\lambda)_v \, e^{-a(\lambda) c \ell} \, d\lambda}{\sum_{i=1}^{n} \int_{\lambda_{1i}}^{\lambda'_{1i}} (N'_\lambda)_v \, e^{-a(\lambda) c \ell} \, d\lambda}}_{\text{IV}} \right\} \qquad (2\text{-}7)$$

and we are left with the equality

[expression (II) = expression (IV)] (2-8)

The assumptions that we must make are that

1) N'_λ is isotropic; that is, it does not depend on (ϕ, γ). Then, $N'_\lambda = (N'_\lambda)v$

2) N'_λ can be expressed as a ratio of H_λ i.e. $N'_\lambda = f(H_\lambda)$ and that this function is known, for a given period of time, ozone thickness etc. Then this ratio will be a function of λ and θ only; $N'_\lambda = H_\lambda f(\lambda, \theta)$

3) The gas is stratified; that is, its concentration is constant over horizontal layers. And the total concentration x pathlength can be expressed $ch = c_1h_1 + c_2h_2 + \ldots\ldots\ldots\ldots c_nh_n$

(cihi is the concentration on layer (i) times the height of the layer (hi) where ci is constant)

4) $Rf(\lambda)$ is constant = R over the interval $\lambda_{11} \leftrightarrow \lambda'_{2n}$

Because of (3) the expression

$$e^{-\alpha(\lambda)\left[\int_0^{\ell} c\,d\ell + \int_0^{h} c_1 dz\right]}$$

reduces to $$e^{-a(\lambda)ch\left[\sec\gamma + 1\right]}$$

and $e^{-a(\lambda)\left[\int_0^{\ell} c_2 d\ell + \int_0^{h} c_1 dz\right]}$ to $e^{-a(\lambda)ch\left[\sec\theta + 1\right]}$

and expression (2-8) becomes

$$\frac{\sum_{i=1}^{m}\int_{\lambda_{2i}}^{\lambda'_{2i}} H_\lambda\, F(\theta,\lambda)\, e^{-a(\lambda)[c\ell]}\, d\lambda}{\sum_{i=1}^{m}\int_{\lambda_{1i}}^{\lambda'_{1i}} H_\lambda\, F(\theta,\lambda)\, e^{-a(\lambda)[c\ell]}\, d\lambda} =$$

$$\frac{\sum_{i=1}^{m}\left[\iiint H_\lambda\, F(\theta,\lambda)\exp\left[-a(\lambda)\,ch(\sec\gamma+1)\right]\sin\gamma\cos\gamma\, d\gamma\, d\phi\, d\lambda + \int H_\lambda\cos\theta\exp\left[-a(\lambda)\,ch(\sec\theta+1)\right]d\lambda\right]_{\lambda_{2i}}^{\lambda'_{2i}}}{\sum_{i=1}^{m}\left[\iiint H_\lambda\, F(\theta,\lambda)\exp\left[a(\lambda)\,ch(\sec\gamma+1)\right]\sin\gamma\cos\gamma\, d\gamma\, d\phi\, d\lambda + \int H_\lambda\cos\theta\exp\left[-a(\lambda)\,ch(\sec\theta+1)\right]d\lambda\right]_{\lambda_{1i}}^{\lambda'_{1i}}} \qquad (2\text{-}9)$$

The second term can be further simplified if $f(\lambda,\theta)$ can be expressed as a product of two other functions, each one depending on only one variable, that is $f(\lambda,\theta) = Z(\theta).L(\lambda)$. The limits of integration of ϕ and γ are:

$\phi \quad 0 \leftrightarrow 2\pi$ $\qquad\qquad$ $\gamma \quad 0 \leftrightarrow \frac{\pi}{2}$

and the expression (2-8) becomes

$$\frac{\sum_{i=1}^{n} Z(\theta) \int_{\lambda_{2i}}^{\lambda'_{2i}} H_\lambda L(\lambda)\, e^{-a(\lambda)[c\ell]}\, d\lambda}{\sum_{i=1}^{n} Z(\theta) \int_{\lambda_{1i}}^{\lambda'_{1i}} H_\lambda L(\lambda)\, e^{-a(\lambda)[c\ell]}\, d\lambda} = \frac{\sum_{i=1}^{n} \int_{\lambda_{2i}}^{\lambda'_{2i}} H_\lambda L(\lambda)\, e^{-a(\lambda)[c\ell]}\, d\lambda}{\sum_{i=1}^{n} \int_{\lambda_{1i}}^{\lambda'_{1i}} H_\lambda L(\lambda)\, e^{-a(\lambda)[c\ell]}\, d\lambda} =$$

(A) (B)

$$\frac{\sum_{i=1}^{n} \left[2\pi Z(\theta) \iint H_\lambda L(\lambda) \exp\left[-a(\lambda)\, ch(\sec\gamma + 1)\right] \sin\gamma \cos\gamma\, d\gamma\, d\lambda + \int H_\lambda \cos\theta \exp\left[-a(\lambda)\, ch(\sec\theta + 1)\right] d\lambda \right]_{\lambda_{2i}}^{\lambda'_{2i}}}{\sum_{i=1}^{n} \left[2\pi Z(\theta) \iint H_\lambda L(\lambda) \exp\left[-a(\lambda)\, ch(\sec\gamma + 1)\right] \sin\gamma \cos\gamma\, d\gamma\, d\lambda + \int H_\lambda \cos\theta \exp\left[-a(\lambda)\, ch(\sec\theta + 1)\right] d\lambda \right]_{\lambda_{1i}}^{\lambda'_{1i}}}$$

(C)

(2-10)

We name the value CR = α(1-B) [expression (2-7) after having been simplified with the given assumptions], the calibrated reading corresponding to the concentration [cℓ].

The problem can be stated as follows:

Which concentration ch below the aircraft would, after following the studied process, give a reading in the calibration curve corresponding to [cℓ]?

The way to solve it is as follows: Knowing $Z(\theta)$, $L(\lambda)$, H_λ and $a(\lambda)$, introduce values of ch and [cℓ] in sides B and C of equation (2-10), and see which value of ch gives a value to the term C equal to a [cℓ] in the term B.

The values ch, [cℓ] in ppm-M can be then entered in a table or tables, for each value of the angle θ. In that situation [cℓ] would be the "readout calibrated concentration" for the angle θ due to the real concentration ch below the aircraft. Then, the concentration ch could be determined with a set of tables for different times of year, geographical locations and sun angles.

If we further assume that

(a) $H\lambda$ has a continuous distribution over the waveband of interest.

(b) $L(\lambda)$ is equal to 1, that is the spectral distribution of $H\lambda$ is equal to that of $N\lambda$.

(c) The width of all slits in the mask is the same.

(d) Two values a_1 and a_2 of $a(\lambda)$ can be found, such that expression (2-10) becomes

$$e^{-(a_2 - a_1)[c\ell]} = \frac{e^{-a_2\, ch(\sec\theta + 1)} + 2\pi Z(\theta)\int_0^{\frac{\pi}{2}} e^{-a_2\, ch[\sec\gamma + 1]} \cos\gamma \sin\gamma \, d\gamma}{e^{-a_1 ch(\sec\theta + 1)} + 2\pi Z(\theta)\int_0^{\frac{\pi}{2}} e^{-a_2 ch[\sec\gamma + 1]} \cos\gamma \sin\gamma \, d\gamma} \qquad (2\text{-}11)$$

For the solution of this formula, the value of $\pi \cdot Z(\theta)$

has been taken as $-\dfrac{450}{8(\theta - 76.25)}$ for SO_2

and as $-\dfrac{42}{\theta - 140}$ for NO_2.

θ, in degrees,

as it was explained in TR-68-56 , "Final Report, Absorption Spectroscopy Experiment", work done on NASA Contract No. NAS9-7241.

A computer program (PATH) has been written to yield values of

$$m = \frac{[c\ell]}{ch}$$

using the values,

$$NO_2 \begin{cases} a_2 = .332 * 10^{-18} \dfrac{cm^2}{molec.} \\ a_1 = .166 * 10^{-18} \dfrac{cm^2}{molec.} \end{cases}$$

and

$$SO_2 \begin{cases} .73 * 10^{-18} \dfrac{cm^2}{molec.} \\ .34 * 10^{-18} \dfrac{cm^2}{molec.} \end{cases}$$

Prepared by *[signature]*
M. Millan
Mathematician

Approved by *[signature]*
J. MacDowall
General Manager
Research and Development Division

September 30, 1968

APPENDIX B

AIRBORNE SO_2/NO_2 MEASUREMENTS
CALCULATION OF CONCENTRATION FROM TOTAL
VERTICAL GAS BURDEN

The total vertical gas burden is considered to be that component of the spectrometer read-out which represents the concentration X pathlength product of the pollutant integrated along a vertical line of sight from ground level to the top of the pollutant layer. Given this quantity plus the temperature at various points throughout the layer and barometric pressure at ground level, the problem is to find the average concentration in the layer.

It should be borne in mind in this discussion that the spectrometer readout is quantitized in flight by calibrations of instrument sensitivity using a reference cell of known gas burden. The spectrometer contains two reference cells (for two different gases) which have been carefully measured or calibrated in the laboratory prior to the survey. For this particular mission the NO_2 cell contained 85.8 ppm-meters and the SO_2 cell 155 ppm-meters of gas-both at 20°C and one atmosphere of pressure.

The integrated vertical burden $c\ell$ in ppm-meters has concentration c in parts per million by volume (i.e., by no. of molecules) at 1 atmosphere and 20°C (293 Å). That is, that number of molecules per unit volume of a gas at 20°C and 1 atmosphere would have c parts per million. Now consider the density of air at 20°C and 1 atmosphere to be 1. At a different temperature T and pressure P the air will have a different density $d = \frac{To}{T} \times \frac{P}{Po} = \frac{293°A}{T} \times \frac{P}{1 \text{ atmos.}}$. If the density is lower (higher) the given amount of pollutant will form a higher (lower) fraction in parts per million of the total.

We assume that the pollutant layer is homogenous, i.e., the pollutant forms a fraction of the layer which is constant with height. The density of the pollutant varies in proportion to the overall density of the air. We divide

the pollutant layer into thin horizontal sub-layers or slices. We assume a concentration of 1 for each slice in parts per million at the temperature and pressure of the slice. We then find the concentration reduced to 20°C and 1 atmosphere. We then find the average concentration k (at 20°C + 1 atm.) of the slices weighted according to the amount of air in each slice.

Now we find the height ℓ between the ground and the top of the pollutant layer. If the integrated burden or thickness is $k\ell$ ppm-m, then the average concentration reduced to 20°C and 1 atm. is k. Also if $c\ell$ is the actual integrated thickness, that is, the total vertical burden in ppm-meters at ambient temperature and pressure, then $c \times \frac{1}{k}$ is the concentration. Now will be described a method to find $\frac{1}{k}$

Refer now to the pollution survey conducted by Barringer Research in Los Angeles on May 22. Refer further to the temperature sounding taken on the ascent. For the purpose of this example we will assume the pollutant layer extends from a ground elevation of 600 feet (m.s.l.) to a maximum height of 5000 feet (m.s.l.).

	(ground)													Calculate To-	Line
Height (m.s.1)	600		1000		1500		2000		3000		4000		5000	nearest 100 ft.	A
Pressure	990		980		960		940		905		875		845	nearest 5 mb	B
Slice Thickness t		10		20		20		35		30		30		nearest 5 mb	C
Rel. Pressure $\frac{P}{1 \text{ atm.}}$		.97		.955		.935		.91		.88		.85		nearest .005	D
Temp. T		287		285.5		284		282.5		280.5		278		nearest 5°A	E
$\frac{T}{293°A}$		.98		.975		.97		.965		.96		.95		nearest .005	F
$\frac{P}{1 \text{ atm.}} \times \frac{293°A}{T} = k$		.99		.98		.965		.95		.915		.895		nearest .005	G
kt		9.9		19.6		19.3		33.2		27.5		26.8		nearest .1 mb	H
Σt = 145 mb				Σkt = 136.3 mb											I
$k_{av.} = \frac{136.3}{145} = .94 \quad \frac{1}{k_{av.}} = \frac{145}{136.3} = 1.065$															J

Line A - height above mean sea level recorded by altimeter at each point at which reading is taken from bottom to top of pollution layer. Readings should be taken at ground and every 1000 feet thereafter until the top of pollution layer. A slice is taken between each pair of levels.

Line B - pressure in mb. at each recording height. This is taken from a U.S. upper air chart based on the U.S. standard atmosphere. If an altimeter corrected for temperature, or a radar altimeter, is used, a different atmosphere will have to be used for hot or cold weather. Remember to add or subtract a correction factor (to nearest 5 mb) if the sea level pressure is above or below the standard 1013 mb. value. In the example the correction factor is 0.

Line C - slice thickness t. This is the difference in pressures (from line B) at adjacent recording heights. This gives the amount of air in each slice.

Line D - relative pressure. Take the mean of the pressures at the endpoints of the slice and divide by the standard mean sea level $\overline{\text{pressure}}$ to get slice pressure in atmospheres. The first value in the example is $\left(\frac{990 + 980}{2}\right) \times \frac{1}{1013} = .97$.

Line E - Temperature T. Take the mean of the temperatures at the endpoints of the slice and convert to absolute. The first value in the example is $\frac{15 + 13}{2} + 273 = 287°A$.

Line F - relative temperature $\frac{T}{293°A}$

Line G - factor k for each slice. Divide the value from line D by that from line F.

Line H - kt. Multiply line C by line G to obtain this intermediate step in finding the average of k.

Line I - Σt (diff. in press. between top and bottom) from line B on (which should give the same answer). Also we have Σkt from line H.

Line J - $k_{av.} = \frac{\Sigma kt}{\Sigma t}$ from line I, $\frac{1}{k_{av.}}$ is also determined.

Suppose the integrated thickness was 120 ppm-m. Divide by the layer thickness 5000-600 = 4400 feet - 1420 meters to get $\frac{120}{1420}$ ppm (20°C, 1 atm.) average volume concentration. Multiply by $\frac{1}{k_{av.}}$ to find the actual average concentration:

$$\underline{\frac{120 \times 1.065}{1420} = .090 \text{ ppm}}$$

Prepared by A. J. Moffat

A. J. Moffat
Project Engineer

and

S. Clodman
Scientist

Approved by J. MacDowall

Joseph MacDowall
General Manager
Research and Development Division

APPENDIX C

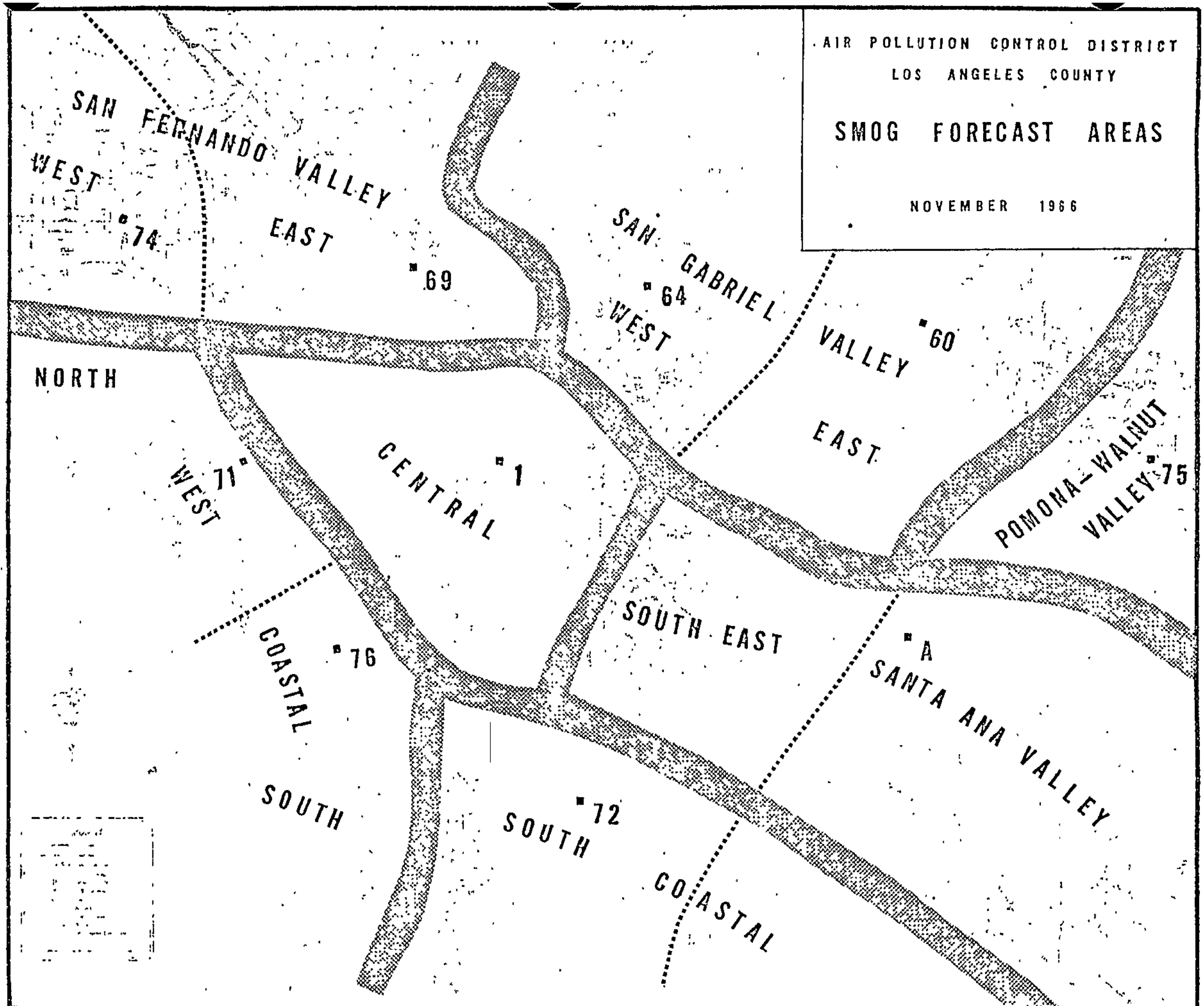
GROUND TRUTH AIR POLLUTION DATA

ACQUIRED BY LOS ANGELES AIR POLLUTION

CONTROL DISTRICT (LAAPCD), LOS ANGELES COUNTY

During the course of the Barringer survey, the concentration of NO_2 and SO_2 in the air at ground level was measured by the LAAPCD. These stations have been in routine operation for 10 to 15 years. The amount of NO_2 in the surface air is measured by the Saltzman reagent method.

The attached figure gives the location of the ground stations. The recorded concentration is given in four tables.


AIR POLLUTION CONTROL DISTRICT
LOS ANGELES COUNTY
SMOG FORECAST AREAS
NOVEMBER 1966
SAN FERNANDO VALLEY
WEST
74
EAST
69
SAN GABRIEL VALLEY
64
WEST
60
EAST
NORTH
WEST
71
CENTRAL
1
POMONA-WALNUT VALLEY
75
COASTAL
76
SOUTH EAST
A
SANTA ANA VALLEY
SOUTH
12
SOUTH
COASTAL

ATMOSPHERIC CONCENTRATIONS OF NO_2 AND SO_2 IN THE LOS ANGELES BASIN

May 21, 1968

No.	STATION Location	Contam-inant	8 AM	9 AM	10 AM	11 AM	12 N	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM *
			HOURLY AVERAGE CONCENTRATION (PPHM)										
1	Central Los Angeles	NO_2	7	7	6	-	-	5	3	5	5	3	3
		SO_2	1	1	-	1	1	1	1	1	1	1	1
60	East San Gabriel Valley	NO_2	3	1	1	1	-	-	-	1	1	1	1
64	West San Gabriel Valley	NO_2	2	3	3	-	-	-	6	5	3	3	3
		SO_2	1	1	1	1	1	-	2	2	2	2	2
69	East San Fernando Valley	NO_2	4	6	7	7	-	-	-	6	6	6	5
		SO_2	1	1	1	-	-	1	2	1	1	1	1
71	West Los Angeles	NO_2	3	3	3	-	-	-	3	3	3	3	3
		SO_2	2	1	-	1	2	2	2	2	2	2	2
72	South Coastal	NO_2	-	-	-	-	-	-	-	-	-	-	6
		SO_2	3	3	6	2	2	2	-	1	1	1	1
74	West San Fernando Valley	NO_2	2	2	2	2	-	-	-	2	2	2	2
		SO_2	2	1	1	-	1	1	1	1	1	1	1
75	Pomona-Walnut Valley	NO_2	2	3	3	3	-	-	-	4	5	6	6
		SO_2	1	1	1	-	1	1	1	1	1	1	2
76	South West Coastal	NO_2	-	-	4	6	-	-	-	4	5	5	4
		SO_2	1	1	2	2	2	1	-	2	3	3	2

* All times used are Pacific Standard Time.

ATMOSPHERIC CONCENTRATION OF NO_2 AND CO_2 IN THE LOS ANGELES BASIN

May 22, 1968

STATION No.	STATION Location	Contaminant	HOURLY AVERAGE CONCENTRATION (PPHM) 8 AM	9 AM	10 AM	11 AM	12 N	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM
1	Central Los Angeles	NO_2	9	9	8	-	5	4	4	4	4	3	3
		SO_2	3	3	3	2	2	-	2	1	1	1	1
60	East San Gabriel Valley	NO_2	3	1	1	1	-	-	-	1	1	1	1
64	West San Gabriel Valley	NO_2	3	4	4	-	-	4	4	3	2	2	2
		SO_2	2	-	2	-	1	1	1	1	1	1	1
69	East San Fernando Valley	NO_2	6	6	7	8	-	-	-	4	4	4	7
		SO_2	-	2	2	2	2	2	2	2	2	2	2
71	West Los Angeles	NO_2	11	9	-	-	-	4	4	3	3	3	3
		SO_2	-	2	1	1	1	1	1	1	1	1	1
72	South Coastal	NO_2	6	5	-	-	-	-	-	-	-	-	-
		SO_2	2	2	2	2	2	2	2	2	2	2	2
74	West San Fernando Valley	NO_2	8	7	5	6	-	-	1	1	1	1	1
		SO_2	2	2	1	1	2	2	2	1	1	1	1
75	Pomona-Walnut Valley	NO_2	2	2	3	4	-	-	2	3	5	4	3
		SO_2	1	-	1	1	1	-	1	2	2	2	2
76	South West Coastal	NO_2	8	8	4	3	5	-	-	3	3	4	3
		SO_2	3	7	-	2	2	2	1	1	1	1	1

* All times used are Pacific Standard Time.

ATMOSPHERIC CONCENTRATION OF NO_2 AND SO_2 IN THE LOS ANGELES BASIN

May 23, 1968

STATION No.	STATION Location	Contaminant	HOURLY AVERAGE CONCENTRATION (PPHM) 8 AM	9 AM	10 AM	11 AM	12 N	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM
1	Central Los Angeles	NO_2	5	6	5	-	5	5	4	5	5	5	4
		SO_2	2	-	2	2	2	2	2	2	2	2	2
60	East San Gabriel Valley	NO_2	1	1	1	1	-	-	-	1	1	1	1
64	West San Gabriel Valley	NO_2	3	2	3	-	-	5	4	3	3	3	3
		SO_2	1	1	1	-	-	2	2	2	2	2	2
69	East San Fernando Valley	NO_2	3	3	5	6	-	-	-	4	5	6	6
		SO_2	2	2	2	2	2	2	2	2	2	2	2
71	West Los Angeles	NO_2	6	5	-	-	-	3	3	3	4	3	3
		SO_2	2	2	3	2	2	1	2	2	1	1	1
72	South Coastal	NO_2	6	5	5	5	-	3	6	7	7	7	5
		SO_2	1	7	1	1	2	3	2	2	1	1	1
74	West San Fernando Valley	NO_2	-	-	3	5	4	3	2	2	2	2	2
		SO_2	1	1	1	1	1	1	1	1	1	1	1
75	Pomona-Walnut Valley	NO_2	3	2	3	3	-	-	-	8	7	7	7
		SO_2	1	-	1	1	1	1	1	1	2	2	2
76	South West Coastal	NO_2	6	6	6	3	-	-	-	6	8	4	2
		SO_2	1	-	3	2	3	2	1	1	1	1	1

* All times used are Pacific Standard Time.

ATMOSPHERIC CONCENTRATION OF NO_2 AND SO_2 IN THE LOS ANGELES BASIN

May 24, 1968

No.	STATION Location	Contaminant	8 AM	9 AM	10 AM	11 AM	12 N	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM*
			HOURLY AVERAGE CONCENTRATION (PPHM)										
1	Central Los Angeles	NO_2	7	9	7	-	-	6	6	7	7	7	7
		SO_2	3	3	3	2	2	2	2	1	2	2	1
60	East San Gabriel Valley	NO_2	1	1	1	1	-	-	-	1	1	1	1
64	West San Gabriel Valley	NO_2	5	4	-	-	-	-	5	4	4	5	6
		SO_2	2	2	1	1	1	1	1	1	1	1	1
69	East San Fernando Valley	NO_2	7	7	11	9	-	-	-	6	8	11	14
		SO_2	2	-	2	2	3	3	2	2	2	2	2
71	West Los Angeles	NO_2	11	9	-	-	-	3	3	4	4	4	4
		SO_2	2	2	1	1	1	1	1	1	1	1	1
72	South Coastal	NO_2	3	3	7	4	-	-	-	3	5	7	10
		SO_2	1	-	-	1	1	1	1	1	1	1	1
74	West San Fernando Valley	NO_2	9	8	8	8	-	-	-	3	4	6	7
		SO_2	2	-	1	1	1	1	1	1	1	1	1
75	Pomona-Walnut Valley	NO_2	6	5	5	5	-	-	-	5	8	8	9
		SO_2	1	-	2	1	1	2	2	-	2	2	2
76	South West Coastal	NO_2	9	5	3	2	-	-	-	1	2	2	1
		SO_2	4	-	2	2	2	1	2	2	2	2	1

* All times used are Pacific Standard Time.

APPENDIX D

WEATHER DATA FOR THE PERIOD MAY 21st TO MAY 24th, 1968

This appendix gives the following weather data for the Los Angeles Basin during the period of our investigation:

(a) A brief summarizing statement of the daily weather.

(b) The upper air temperature/pressure sounding at Los Angeles.

(c) Surface weather for the following stations:-

LAX	Los Angeles Airport
BUR	Burbank
LGB	Long Beach
SAN	San Diego
SBA	Santa Barbara
SDB	Sandberg
SBD	San Bernardino
RIV	Riverside
BUO	Beaumont
PSP	Palm Springs
TRM	Thermal
IPL	Imperial
ONT	Ontario

These data were compiled by the Geography Department of the University of California, Riverside.

TUESDAY, May 21st, 1968

Stratus with a ceiling of about 1000 feet persisted over the coast all night and invaded the inland valleys at 4 a.m. At sunrise the stratus lifted (to a ceiling of about 3000 feet) and became quite unstable - a light shower fell at Riverside and others were observed in the Perris block. Broken cumulus to stratocumulus with a ceiling of about 3000 feet persisted the rest of the day. Visibilities were good at all areas all day and temperatures much cooler. The Coachella Valley again experienced dust in the evening hours. Soundings indicated an inversion at 4000-5000 feet and general cooler temperatures aloft as a result of an approaching trough.

WEDNESDAY, May 22nd, 1968

While scattered stratocumulus clouds occurred over coastal valleys in the early morning, surface heating produced a broken to complete stratocumulus cloud cover after sunrise, while the cloud cover persisted all day, some clearing took place along the immediate coast. Ceilings were about 3000 feet.

Soundings reported an inversion at 4000 feet which was largely destroyed by evening hours.

Visibilities were again good except in the San Bernardino -Riverside area in the early morning.

Deserts experienced severe dust storms most of the day and temperatures were again much cooler.

THURSDAY, May 23rd, 1968

A broken stratocumulus cover with a ceiling of 4000 feet resulting from morning surface heating, dominated skies over the coastal valleys, although more extensive clearing took place in the afternoon. Soundings indicated an ill defined inversion at about 5000 feet.

Persistent breezes maintained the good visibility pattern at all areas.

The air aloft remained relatively cool and slightly unstable, particularly over the interior (LAS VEGAS), as a trough passed into the Great Basin. As a result, flow aloft began to shift from westerly to northwesterly, a pattern which continued into Friday.

Dust storms were less severe in the Coachella Valley.

FRIDAY, May 24th, 1968

As the trough continued eastward from the Great Basin, the somewhat unsettled weather of prévious days disappeared, temperatures warmed up, winds decreased, and visibilities also decreased. Cloudiness was restricted to a few cumulus in the norming hours and a band of cirris in the evening. There was considerable smoke and haze along coastal areas until noon and interior valleys until evening.

Sondings indicated redevelopment of an inversion at about 2000 feet.

Tuesday

May 24, 1968

HOUR Midnite 0000
(Pacific Daylight Time)

STATION	Clouds	Visibility	Barometric Pressure (mb)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	Stratus overcast 700 ft	8	1014,5	61	57	SW	8	ceiling rigid lower west
BUR	broken stratus 2500 ft	15		63	58	SE	4	
LGB	stratus overcast ceiling 200 ft [illegible]	3 fog	1015,2	60	58	S	7	
SAN	" 1000 ft	12	1015,2	65	57	NW	2	
SBA		10	1014,6	56	55	—	0	
SDB		—						
SBD		8		58	54	—	0	
RIV		7		56	50	—	0	
DUO								
PSP								
TRM		15	1007,5	80	52	N	15	
IPL		20	1008,5	80	50	NW	8	
ONT		10		60	56	SW	1	

Tuesday ✓

DATE May 21, 1968 HOUR 10 am 1000 (Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	broken Strato-Cumulus 2500 ft	10	1014.0	65	55	SW	7	
BUR	"	10		64	55	SE	5	
LGB	Stratus overcast 2500 ft 1500 ft	6 Haze Smoke	1014.6	65	57	N	4	
SAN	" 1900 ft	15	1014.9	64	53	SW	6	Strato cumulus NE-SE
SBA		15	1014.6	63	53	S	9	heavy cumulus topping mtns
SDB	broken sky 800 ft	20		45	36	N	17	
SBD	broken Stratus 3500 ft	15		64	50	—	0	
RIV	" 3000 ft.	30		64	48	S	6	
BUC								
PSP		30		82		NW	17	
TRM		10	1007.8	81	46	NW	12	Blowing dust SE-SW
IPL		40	1007.8	89	26	W	15	
ONT	broken Stratus 2500 ft 1600 F	4 Haze		68	53	W	4	

Tuesday

DATE May 21, 1968 HOUR 11 am 1100 (Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	broken Strato Cumulus 3000 ft	10	1014.5	66	55	SW	10	
BUR	"	10		67	53	SE	3	
LGB	" 2500 ft	7	1014.9	67	57	S	8	
SAN	Stratus Overcast 2700 ft 2000 ft	15	1014.9	65	52	SW	10	
SBA		20	1014.9	65	51	S	8	
SDB				47	36	N	16	
SBD	Few cumulus 5000 ft	25	1012.8	68	50	SE	5	
RIV	broken cumulus 3500 ft	30	1012.4	68	47	S	4	
BUO	Few Strato cumulus	25		65	48	SW	5	
PSP		30		83		NW	15	Gusts to 30
TRM		15	1007.5	85	39	N	5	
IPL		40	1007.8	92	30	W	17	Gusts to 24
ONT	broken Strato Cumulus	7		70	48	S	5	

Tuesday

DATE May 21, 1968

HOUR Noon ~~Ham~~ 1200 (Pacific Daylight Time)

STATION	Sky [illegible]	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	few cumulus 3300 ft	10	1014.4	68	55	SW	10	
[illegible]	" 3500 ft 1500 ft	10		70	53	SE	10	
LGB	2500 ft 1500 ft	12	1014.6	69	56	S	11	
SAN	broken stratus 2200 ft 3300 ft	30	1014.9	66	51	SSW	7	
SBA		20	1014.9	67	51	SE	10	few cumulus along mtns
SDB	broken cumulus 1400 ft	50		51	36	NNW	10	Strato cumulus topping higher mtns
SBD	few cumulus 3500 ft			71	50	W	1	
RIV	" 3500 ft			70	47	SSE	2	
[illegible]								
PSP		30		85	~~[illegible]~~	NW	15	
TRM		15+	1007.1	88	39	N	7	
IPL			1007.1	95	31	W	15	Gusts to 22
ONT	broken strato cumulus 2800 ft 1600 ft			72	52	SW	9	

Tuesday

DATE May 21, 1968 HOUR 1 pm 1300
(Pacific Daylight Time)

STATION	Clouds	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX		10	1014.5	70	56	SW	13	Strato cumulus E-S
BUR	broken Stratocumulus	10		73	54	SSE	6	
LGB	"	15	1014.6	69	56	SSW	8	
SAN	"	30	1014.9	70	52	SW	9	
SBA	few cumulus 3500 ft	20	1014.9	67	51	SE	10	
SDB	broken sky ceiling 1500 ft	50		52	36	NNW	9	Strato cumulus higher mtns
SBD	Few cumulus 5000 FT	25		74	50	NW	6	
RIV		35		71	48	SSE	6	Few cumulus
SUG		25		67	46	W	3	
PSP		30		88		NW	22	
TRM		20	1006.4	92	38	WNW	7	
IPL		40	1006.4	94	30	NW	15	Gusts to 21
ONT	Few cumulus	7	-	72	52	SW	10	

DATE May 21, 1968 Tuesday HOUR 2 pm 1400
(Pacific Daylight Time)

STATION	[illegible]	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX		10	1014,0	71	56	SW	12	Stratus E-S
BUR	broken Strato Cumulus	15		73	54	SE	6	
LGB	"	20	1014,2	70	55	S	10	
SAN	Few cumulus 2700 ft 3500 ft	20	1014,6	67	50	SW	8	
SBA	"	20	1014,2	67	52	SE	10	
SDB		50		54	36	NNW	11	Stratocumulus higher mtns
SBD	Few cumulus 5000 ft	15	1011,6	74	51	WNW	10	Visibility lower W
RIV	" 3500 ft	35	1011,4	72	48	SE	7	
BCD								
PSP		30		89		NW	30	
TRM		20	1005,8	92	37	NNE	16	
IPL		40	1006,4	96	37	WSW	20	Gusts to 28
ONT	Few cumulus 3000 ft	7		74	52	SW	17	

DATE May 21, 1968 Tuesday HOUR 3pm 1500
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX		15	1013.6	69	55	WSW	12	Stratocumulus ENE-S
BUR	Broken Strato-cumulus 4500 ft	15		72	53	S	5	
LGB	Few strato-cumulus 2500 ft	20	1013.9	72	55	SSE	11	
SAN	" 2700 ft	20	1014.2	68	50	SW	7	
SBA		25	1013.5	67	50	WSW	12	Gusts to 20 Cumulus N-NE
SDB				56	36	NNW	13	Stratocumulus along higher mtns
SDD		8		73	51	NW	9	Cumulus N + S
RIV	Few Cumulus 3500 ft	25		72	51	NW	9	
BUO		25		74	48	SW	6	
PSP		30		89		NW	30	
TRM		10	1005.1	93	35	NW	11	
IPL		40	1005.8	95	39	WSW	18	Gusts to 25
ONT	Few Cumulus 3000 ft	10		74	52	WSW	11	

DATE May 21, 1968

HOUR 4 pm 1600
(Pacific Daylight Time)

STATION	Sky [illegible]	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
[illegible]		15+	1013.1	70	53	WSW	15	
[illegible]	Broken Cumulus 4500 ft	15		71	53	SSE	4	
LGB		25	1013.2	70	55	SW	10	Few Stratocumulus, altocumulus
SAN	Few-Strato cumulus 3500 ft	20	1013.9	68	51	SW	10	
[illegible]		25	1012.5	67	49	WSW	18	cumulus dissapatin
[illegible]				54	31	N	10	
[illegible]	Few cumulus 7000 ft	8		75	54	W	9	
[illegible]		20		73	51	NW	11	Gusts 17 Stratocumulus N-E + S
ELD								
[illegible]								
TRM		15+	1004.4	95	39	N	8	
IPL		30	1004.7	94	32	W	19	Gusts to 27
ONT	Few cumulus 3000 ft	10		72	52	SW	14	

DATE May 21, 1968

HOUR 5PM 1700
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX		20	1012.8	68	53	SW	12	
BUR	broken Cumulus	20		69	52	S	4	
LGB		25	1013.2	70	53	W	12	
SAN	Stratus overcast 3000 ft	20	1013.9	65	53	SW	18	
SBA		25	1022.2	67	48	SW	15	Gusts 22. Few Cumulus NW
SDB		8		55	37	N	11	
SBD	Few Cumulus 7000 ft	15	1010.8	73	53	W	9	
RIV		25	1010.4	71	50	NW	11	Stratocumulus E-S
SUD	Broken Cumulus 6000 ft			72	49	SW	6	
PSP	—	~~15~~						
TRM		~~30~~ 15	1004.1	93	45	N	15	Gusts 20 Dust S-W-N
IPL		30	1004.4	92	31	W	15	Gusts 25
ONT	Few Cumulus 3000 ft	8		71	52	SW	14	

D 13

Wed

DATE May 22, 1968

HOUR Midnite
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX		10	1012.5	58	52	SW	6	Few stratus, altocumul NE
BUR	Few cumulus 4000ft	10		60	50	SE	3	
LGB		12	1013.2	59	56	S	7	few stratus
SAN	Stratus overcast 2300ft	10	1013.5	63	53	W	8	
SBA		15	1012.9	61	42	SW	5	
SDB				44	32	NW	19	
SBD	Overcast 6000ft	10		58	49	SW	3	
RIV	Few cumulus 6000 ft	15		57	48	SE	2	
SUO								
PSP								
TRM		7	1005.8	69	49	NW	20	Gusts 25, dust clouds
IPL		20	1006.1	66	44	W	15	Gusts 20
ONT	broken cumulus 4000ft	15+		59	49	SW		

DATE May 22, 1968

HOUR 10 am
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	few strato cumulus 1800 ft	10	1013.3	68	54	SW	5	
BUR	" 3000 ft	10		65	49	SE	6	
LGB	" 2000 ft	14	1013.9	65	54	S	6	
SNA	" 3500 ft	15	1014.2	66	50	S	8	
SBA		25	1013.9	67	44	S	6	
SDB		50 +		43	31	NNW	20	Rotor clouds N large cumulus NE
SBD	broken Stratocumulus 4500 ft	8		61	49	WNW	4	
RIV	" 2400 ft 5500 ft	20		62	45	W	3	
[illegible]	Overcast 1500 ft	3 Haze		55	47	SW	5	
PSP	Few [illegible] Clouds	10		77		NW	6	Clouds in Pass NW Dust N, NE, E, SE
TRM	[illegible] Overcast	7	1007.5	76	45	NW	16	Gusts, 22 Dust
IPL		30	1007.8	75	40	W	12	
ONT	broken Strato cumulus	9		61	49	WSW	7	

DATE May 22, 1968

HOUR 11 am
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	few Strato Cumulus 2000 ft	15	1013.5	69	54	WSW	10	
BUR	" 3000 ft	10		68	50	SE	5	
LGB	" 2000 ft	15	1014.2	66	54	SSE	8	
SAN	" 3500 ft 5000 ft	15	1014.2	67	49	SW	6	
SBA		25	1013.5	72	44	NW	7	
SDB		50+		46	32	NNW	16	large Cumulus N
SSD	broken strato-cumulus 4500 ft	10	1012.7	63	47	W	6	
RIV	" 5000 ft	20	1012.0	63	44	W	2	
DUO	Overcast 3000 ft	3 Haze		57	45	W	5	
PSP		10		79		NW	20	Dust E
TRM		7	1007.8	78	46	NW	20	Dust
IPL		30	1007.8	79	39	NW	12	Dust
ONT	broken Stratocumulus 1500 ft 3500 ft			63	49	ENE	7	

DATE May 22, 1968

HOUR Noon (Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	broken strato cumulus 2000 ft	15	1013.7	68	55	SW	13	
BUR	" 3000 ft	10		70	47	SSE	5	
LGB	" 2000 ft	15	1014.2	67	52	SW	8	
SAN	" 3500 ft	15	1014.6	67	50	SW	8	
SBA		25	1013.5	71	45	SW	15	Gusts to 20 few cumulus NE
SDB		50 +		49	34	N	14	large cumulus over Mtn tops
SBD	broken Stratocumulus 5000 ft	15		65	47	NW	8	
RIV	"	20		66	44	WNW	7	
BUO	—							
PSP		10		79		NW	32	Dust NW–SE
TRM		6 Dust	1007.5	80	44	N	14	Gusts 22 Dust
IPL		30	1007.8	86	40	WNW	12	Gusts 19
ONT	broken Stratocumulus 1500 ft 3800 ft			67	48	W	7	
VNY	Broken cumulus 4500 ft	10				SSE	13	
FUL	broken cumulus 2000 ft	10				SSW	11	

DATE May 22, 1968 HOUR 1 PM (Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	few cumulus 2000 ft	15	1013.1	68	55	SW	10	
BUR								
LGB	2000 ft	15	1013.9	69	52	S	11	
SAN	" 3500 ft	15	1014.2	67	52	SW	7	
SBA		25	1012.5	69	46	SW	21	Gusts 28 Dust airy few stratocumulus ENE
SDB		50+		51	33	N	10	Mtn tops obscured by large cumulus
SBD	broken stratocumulus 5000 ft	15		69	48	WNW	7	-
RIV	"	12		68	44	NW	5	Visability lower W-N
BUO	~~broken strato~~ " 5000 ft	5 Haze		64	44	SW	5	
PSP		10		81		NW	25	Gusts 35 Dust E
TRM		6 Dust	1006.4	83	41	NW	12	Gusts 18
IPL		30	1007.1	85	41	SW	15	Gusts 25
ONT	broken strato cumulus	9		68	~~55~~ 48	SW	8	
NNY	Broken cumulus 4500 ft	10				SSE	20	
FUL								

DATE May 22, 1968

HOUR 2 pm
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	few Strato Cumulus 2000 ft	15	1012.8	68	55	SW	13	
DUR	" 3000 ft	10		72	50	S	7	
LGB	" 2000 ft	15	1013.5	69	52	SSW	12	
SAN	" 3500 ft	15	1013.9	68	51	SW	11	
SBA			1012.2	69	48	SW	15	Gusts 25
SDB		50+		53	33	NW	13	Mtn tops obscured by large cumulus
SBD								
RIV								
BUO								
PSP								Dust E
TRM		6 Dust	1006.1	86	43	NW	14	Gusts 22 Dust
IPL		30	1006.5	87	~~36~~ 41	SW	[illegible] 14	
ONT	broken cumulus 4000 ft	9		69	48	SW	8	
VNY	Broken cumulus 4500 ft	10				SSW	15	
FUL	few cumulus 2000 ft	20				S	10	

DATE May 22, 1968

HOUR 3 PM
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX		15+	1012.6	69	51	SW	12	large cumulus NE–SE
BUR	few cumulus 3000 ft	10		72	48	S	6	
LGB	" 2000 ft	15	1013.2	70	52	SW	11	
SAN	" 2600 ft	15	1013.2	67	51	SW	9	
SBA		25	1011.5	72	46	W	20	Gusts 26 few stratocumulus Mtns N.
SDB		50+		56	34	N	7	Mtn tops obscured NW–NE
SBD	broken stratocumulus 5000 ft	15		68	47	W	7	
V	"	20		71	44	WNW	6	moderate cumulus E–S
BUO	broken strato cumulus	5 Haze		65	44	SW	4	large cumulus
PSP		10		83		NW	25	Gusts 35
TRM		7	1005.1	85	41	NNW	16	Dust
IPL		30	1006.1	86	41	WSW	14	Gusts 21
ONT	broken Strat. ~~Str~~ cumulus 4000 ft			69	49	SW	11	
VNY	broken cumulus 4500 ft	10				SSW	15	
FUL	few cumulus 2000 ft	10				SW	10	

DATE ~~8-22~~ May 22, 1968

HOUR 4 PM
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX		15+	1011.9	68	50	SW	20	~~Gr~~ Cumulus E-SE
BUR	few strato-cumulus 3000 ft	25		73	45	S	5	
LGB	"	14	1012.5	71	47	W	14	
SAN	" 2500 ft	15	1012.9	67	52	SW	12	
SBA		20	1011.2	72	46	W	20	Gusts 27 few Stratocumulus NNE-EN
SDB				53	31	NNW	15	
SBD	broken Strato cumulus 5000 ft	12		67	49	W	10	
RIV	few Stratocumulus 5000 ft	20		70	44	NW	12	Gusts 21 moderate cumulus NE-SE
BUO	–						–	
PSP		10		82		NW	25	Gusts 35 Dust NW-SE
TRM		7	1004.4	85	42	NNW	16	Gusts 22
IPL		30	1005.8	85	42	W	13	Gusts 24
ONT	broken cumulus 4000 ft	7		67	50	WSW	17	

DATE May 22, 1968

HOUR 5 pm
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX		15+	1012.6	59	51	SW	12	large Cumulus NE-SE
BUR	Few cumulus 3000ft	10		72	48	S	6	
LGB		15	1013.2	70	52	SW	11	
SAN	" 2600 ft	15	1013.2	67	51	SW	9	–
SBA		25	1011.5	72	46	W	20	Gusts 28 Stratocumulus mtns NE-NW
SDB								
SBD	broken Strato-cumulus 5000 ft	15		68	47	W	7	
RIV	"	20		71	44	WNW	6	Moderate cumulus E - S
BUO	"	5 Haze					—	
PSP		10		83		NW	25	Gusts 35 Dust E-NE
TRM		7	1005.1	85	41	NNW	16	Dust SW-NW
IPL		30	1006.1	86	41	WSW	14	Gusts 21
ONT	broken Stratocumulus 4000ft			69	49	SW	11	
VNY	Few cumulus 4500 ft	15				SW	12	
FUL	Few cumulus 2000ft	10				SSW	10	

Times

D 22

DATE May 23

HOUR ~~[illegible]~~ Midnite
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX		10	1011.5	58	52	S	5	
BUR		15+		59	50	ESE	4	
LGB		14	1012.5	58	51	S	5	
SAN	broken stratus	15	1013.2	61	50	W	5	
SBA		15+	1012.5	59	45	NNW	15	
SDB		—						
?BD		—						
RIV		15		51	44	~~S~~SSE	2	
BUO								
PSP								
TRM		8	1006.1	68	50	N	20	
IPL		20	1007.1	63	41	W	13	Gusts 23
ONT		15+		53	47	NW	8	

Thurs

DATE May 23, 1968   HOUR 10 am
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	broken Stratus 2000 ft	7	1013.9	66	48	ESE	10	
BUR	Few Stratus 2500 ft	15		63	48	SE	4	
LGB	" 1800 ft	12	1014.6	64	51	S	7	
SAN		25	1014.2	65	49	SSW	12	few stratocumulus
SBA	Cirrus Few	15	1014.6	62	50	SE	10	
SDB				49	31	NNW	7	Mtn tops obscured N
SBD	broken Stratocumulus 5000 ft	10		59	46	—	0	
[illegible]IV	" " 2800 ft	20		58	44	—	0	
BUO	—							
PSP		20		74		NW	8	Dust E
TRM		6 Dust	1009.5	74	40	NNW	12	
IPL		40	1009.8	75	39	NW	10	
ONT	Broken Stratus 2200 ft	7			48	SW	4	

DATE May 23, 1968

HOUR 11 am
(Pacific Daylight Time)

STATION	Cloudiness	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	few stratus 2200 ft	8	1014.3	65	55	SW	9	
BUR	" 3000 ft	15		65	59	ESE	5	
LGB	" 2000 ft	15	1014.6	67	52	S	9	
SAN		20	1014.6	66	49	SSW	8	
SEA		15	1014.9	61	50	SSE	7	
SDB				52	31	N		
SBD								
RIV								
EUO	broken overcast 3500 ft	5 Haze		56	43	WSW	4	
PSP		30		77		NW	10	
TRM								
JPL		40	1009.5	79	39	NNW	6	
ONT	broken overcast 2200 ft	7		61	47	NW	7	
VNY	~~few~~	10				S	8	
FUL	few cumulus 2000 ft	7				S	10	

DATE May 23, 1968

HOUR NOON
(Pacific Daylight Time)

STATION	[illegible]	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
LAX	few cumulus 2500 ft	10	1014,3	66	57	SW	9	
[illegible]	broken strato cumulus 2400 ft	10		69	48	S	5	
LGB	" 2000 ft	15	1014,9	68	52	SSW	6	
SAN		20	1014,6	68	49	SW	8	
SGA		15	1014,9	62	50	SE	9	Few cumulus over mtns
SDB				52	31	N	11	
SBD	few cumulus 5000 ft	10		64	46	⊙	—	
RIV	" 4000 ft	20		66	43	NW	9	
SUO								
PSP		30		81		NW	15	
[illegible]								
[illegible]		30	1009,5	81	38	W	8	
ONT	broken strato cumulus 2500 ft	6 Haze		64	48	N	7	
VNY		10				S	8	
FUL	Few cumulus 2500 ft	7				SW	10	

Thurs
May 23, 1968

1 PM

	few cumulus 2500 ft	12	1014.0	67	57	SW	12	
	—							
	" 2000 ft	15	1014.6	66	51	SSE	7	
		20	1014.6	68	49	WSW	9	
		15	1014.9	65	47	E	9	
		50		52	31	N	14	
	few cumulus 5000 ft	10		64	45	W	4	
	" 4000 ft	15		67	43	NW	10	
		25		65	43	SW	3	Cumulus clouds
		30		82		NW	22	
		15	1008.8	83	35	E	4	
		50	1008.5	84	30	WNW	7	
ONT	broken cumulus 2500 ft	6 Haze		69	47	NW	1	
VNY		~~10~~						
FUL	few cumulus 2000 ft	7						

May 23, 1968 2 PM

[illegible]	[illegible]	[illegible]	Pressure (mb)	[illegible]	Dew Point	Wind Direction	Wind Speed	
[illegible]	few cumulus 2500 ft	13	1014,0	67	55	SW	15	
[illegible]	broken cumulus 2500 ft	8		70	50	S	7	
[illegible]	"	15	1014,2	69	51	S	12	
[illegible]		20	1014,2	68	51	SW	10	
[illegible]		20	1014,2	65	51	SE	12	few cumulus Mtns
[illegible]		50		55	32	NNW	17	
[illegible]		10	1012,9	67	45	NNW	6	Stratocumulus S
[illegible]	few cumulus 4500 ft	10	1012,1	70	43	NNW	5	
[illegible]	—							
[illegible]		25		83		NW	23	
[illegible]		15+	1007,8	85	36	NNW	8	
[illegible]		50	1008,1	88	37	NNW	8	
ONT	few cumulus 2500 ft	7		72	46	NNW	1	

NOT REPRODUCIBLE

May 23, 1968 3 PM

[illegible]	[illegible]	[illegible]	[illegible] Pressure (MB)	Temper-ature	Dew Point	Wind Dir-ection	Wind Speed	[illegible]
		12	1013.8	66	57	SW	16	Few cumulus Stratocumulus
	few strato-cumulus 2500 ft	8		72	49	ESE	8	
	few cumulus 2500 ft	15	1013.9	70	51	S	11	
		20	1014.2	68	52	SW	8	
		20	1014.2	65	52	SE	10	
		50		55	32	NNW	12	
		10		69	44	N	7	Stratocumulus S-SW
	few cumulus	15		72	43	NW	8	
		25		83	[illegible]	NW	23	Gust 33
		15+	1007.5	86	35	SW	6	
		40	1007.5	90	40	N	3	
ONT	Cumulus 2500 FT	7		72	47	N	1	
VNY								
FUL	~~Few cumulus 2000 FT~~	~~10~~ ~~7~~				~~S~~ ~~S~~	~~8~~ ~~10~~	
VNY	broken cumulus 3000 FT	15				SE	10	
FUL	2500 Cumulus	15+				S	10	

May 23, 1968 4 PM

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Dew Point	[illegible]	[illegible]	[illegible]
	—							
	few cumulus 3000ft	10		72	49	SE	8	
		20	1013.5	71	48	S	11	
	〃	20	1013.9	67	52	SW	7	
		20	1013.2	71	48	SW	11	
	few cumulus 5000ft	10		72	46	W	10	
	〃 4000ft	15		72	44	NW	8	
	—							
		20		85		NW	22	Gust 35
		15+	1007.1	87	35	N	10	
		40	1006.8	91	36	SW	10	
ONT	few cumulus 2500ft	7		72	48	~~N~~		
VNY	Broken cumulus 3000 ft	15				SE	10	
FUL	2500 few cumulus	15+				S	10	

NOT REPRODUCIBLE

May 23, 1968

[illegible] 5 PM

[illegible]		14	1013.3	66	51	WSW	14	Few cumulus S
[illegible]	few cumulus 3000 ft	15		72	48	SW	6	
[illegible]		20	1013.5	69	48	WNW	9	
[illegible]	Few strato-cumulus 1800 ft	20	1013.9	66	52	WSW	6	
[illegible]		20	1012.5	74	46	NNW	8	Smoke layer offshore few cumulus mtns ↑
[illegible]				56	30	N	16	
[illegible]	Few cumulus 5000 ft	10	1012.0	71	48	WSW	10	
[illegible]	" 4000 ft	20	1011.3	70	46	NW	12	
[illegible]		3 Haze		70	41	W	5	Cumulus SE-S
[illegible]		20		83		NW	18	Gusts 30
[illegible]		15+	1006.1	87	37	NW	9	
[illegible]		30	1006.4	90	36	W	15	Gusts 23
ONT		7		70	49			
RUL	Few cumulus 2500 ft	15+				S	10	
VNY	" 3000 ft	15				S	15	

D 31

May 23 Thurs 11 PM

		12	1013.6	57	50	WSW	8
		10		60	49	SE	3
		15+	1014.2	58	50	N	4
	broken Stratus 1900 ft	15	1014.6	61	51	SW	5
		15+	1014.2	59	45	NW	12
				45	28	NNW	23
	broken Stratocumulus 5300 ft	8	1013.6	57	47	—	0
	Few cumulus 4500 ft	10	1013.3	55	43	—	0
	—						
	—						
		10	1007.8	70	47	NNW	18
		20	1008.5	68	35	W	13
ONT		15		57	46	~~NE 21~~	

NOT REPRODUCIBLE

May [illegible] 9am

	Few cumulus 2000 ft	6 Haze Smoke	1016.0	64	52	SE	6	
		12	~~[illegible]~~	62	50	SE	3	
	broken strato-cumulus 2000 ft	8	1016.6	65	53	SE	7	
		20	1016.3	64	48	SSW	5	
		15+	1016.6	62	51	SE	9	Hazy east
		50+		49	28	NNW	11	
	Few cumulus 4000 ft broken cirrus	6 Haze Smoke		57	48	—	0	
	broken stratus 1000 ft	7		54	45	S	4	
	Few cumulus 1500 ft	2 Haze		53	46	NW	4	
		15		72		NW	16	
		7	1012.2	72	45	NNW	9	
		30	1012.2	72	42	NW	7	
ONT	Few cirrus	5 Haze		59	49	—	—	

Fri
May 24, 1968

NOT REPRODUCIBLE

10 am

[illegible]	[illegible]	[illegible]	Barometric Pressure (mb)	[illegible]	Dew Point	Wind Direction	Wind Speed	[illegible]
[illegible]	few cumulus 2000 ft	9	1016.4	67	52	S	6	
[illegible]		10		65	47	ENE	5	
[illegible]	11		1016.9	67	53	SSW	11	
[illegible]		20	1016.3	65	49	SSW	4	
[illegible]		15	1016.9	64	52	SE	10	
[illegible]		50+		51	29	NNW	17	
[illegible]	broken stratocumulus 4000 ft	6 Haze Smoke		58	48	—	0	
[illegible]	few cumulus 1500 ft	7		58	45	S	3	
[illegible]		3 Haze		56	46	W	5	
[illegible]		15		76		NW	12	
[illegible]		7	1012.2	~~77~~ 75	~~[illegible]~~ 42	NW	~~[illegible]~~ 4	High clouds
[illegible]		~~25~~ 30	1012.5	77	41	NW	7	
[illegible]NT	few cirrus	4 Haze		63	49			

Fri May 24, 1968 11 am

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		10	1016.6	68	53	SW	10	Cumulus N-E-
[illegible]		10		70	50	S	5	
[illegible]	Few cumulus 6000 ft	10	1017.3	68	54	S	9	
[illegible]		20	1016.3	68	49	SW	8	
[illegible]		20	1017.3	65	51	E	10	
[illegible]		50+		54	22	NNW	12	
[illegible]	Few cumulus 4000 ft	6 Haze Smoke	1016.3	61	49	–	0	
[illegible]		7	1015.9	65	45	ENE	2	
[illegible]		5 Haze		61	43	W	4	
[illegible]		15		83		NW	4	
[illegible]		10	1012.2	80	40	–	0	
[illegible]		20	1012.5	80	42	NW	8	
ONT	Few cirrus	4 Haze		67	48	~~[illegible]~~		

Fri May 24, 1968 NOON

[illegible]	[illegible]	Visibility	Barometric Pressure (mb)	Temperature	Dew Point	Wind Direction	Wind Speed	Remarks
[illegible]		12	1016,9	68	53	SW	12	Cumulus N-E-S
[illegible]		7		71	50	SE	5	
[illegible]	few cumulus 2500 ft	10	1017,3	62	53	S	8	
[illegible]		20	1016,9	68	50	SW	10	
[illegible]		20	1017,3	63	50	SE	10	
[illegible]		50 +		57	25	N	–	Cirrus N
[illegible]		6 Haze Smoke		66	50	–	0	
[illegible]		10		67	44	WSW	2	
[illegible]	–	~~15~~						
[illegible]		15		83		E	9	
[illegible]		15	1012,2	85	39	NW	5	
[illegible]		20	1012,5	82	39	N	6	
ONT		4 Haze		71	49	~~SW~~		

Fri

May 24, 1968

1 PM

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Dew Point	Wind Direction	Wind Speed	[illegible]
[illegible]		12	1016.9	69	52	SW	12	– few cumulus
[illegible]		7		73	51	SE	5	
[illegible]		14	1017.3	70	52	S	10	
[illegible]		20	1016.9	69	50	W	9	
[illegible]	few cirrus	20	1017.6	62	51	SSE	8	
[illegible]	—	50+		61	30	N	10	
[illegible]		7		70	48	W	6	
[illegible]		10		70	43	WSW	5	Gusts !!
[illegible]		5 Haze		68	43	SW	4	
[illegible]		20		86		E	3	
[illegible]		15	1011.5	88	34	SE	6	
[illegible]		20	1012.2	85	36	NW	8	

ONT	—			
VNY	few cirrus	1.0	S	14
FUL	few cumulus 2500 ft	7	SSW	4

May 24, 1968 2 pm

[illegible]	[illegible]	Visibility	Barometric Pressure (mb)	Temperature	Dew Point	Wind Direction	Wind Speed	COMMENTS
[illegible]	Few cirrus	12	1016.6	69	52	SW	12	
[illegible]		7		74	52	SSE	7	
[illegible]	Few cirrus	15	1016.9	72	52	SW	12	
[illegible]		20	1016.9	68	50	NW	5	
[illegible]	Few cirrus	20	1017.3	65	49	SE	10	
[illegible]	"	50 +		59	30	N	11	
[illegible]		6 Haze Smoke	1015.3	72	46	S	6	
[illegible]		7	1015.2	71	43	WNW	10	Gusts to 20
[illegible]								
[illegible]		20		87		NW	10	
[illegible]		15	1011.2	89	31	E	8	
[illegible]		20	1011.9	88	42	NNE	7	
ONT	Few cirrus	5 Haze		75	47	W	10	
VNY	"	10				S	15	
FUL		5 Haze				SSW	8	

NOT REPRODUCIBLE

Fri May 24, 1968

3 pm

[illegible]	[illegible]	Visibility	Barometric Pressure (mb)	Temperature	Dew Point	Wind Direction	Wind Speed	Remarks
[illegible]	Few cirrus	13	1016.6	69	53	SW	13	
[illegible]	"	7		75	52	S	5	
[illegible]	"	15	1016.9	73	50	SSW	13	
[illegible]		20	1016.6	67	51	W	9	
[illegible]		20	1017.3	63	52	SE	12	Few cirrus
[illegible]		50+		59	31	N	23	Gust 36
[illegible]	Few cirrus	7		76	47	W	5	
[illegible]								
[illegible]		3 Haze		75	44	W	6	
[illegible]		20		90		NW	11	
[illegible]		15+	1010.8	90	29	N	6	
[illegible]		25	1010.5	88	36	NW	9	
ONT	Few cirrus	4 Haze		77	48	SW	11	
VNY	"	10				SE	14	
FUL	"	5 Haze				SW	9	

May. 24, 1968. Fri   4 PM

Station	[illegible]	Visibility	Barometric Pressure (mb)	Temperature	Dew Point	Wind Direction	Wind Speed	[illegible]
[illegible]	few cirrus	10	1016.4	68	54	SW	11	
[illegible]		7		75	51	S	4	
[illegible]	"	15	1016.3.	75	49	NW	10	
[illegible]	"	20	1016.3	70	50	NW	9	
[illegible]		20	1016.9	63	51	SE	8	
[illegible]				60	31	NNW	21	
[illegible]	broken cirrus	7		76	47	WSW	6	
[illegible]	"	8		75	45	NW	10	
[illegible]	—							
[illegible]	"	20		91	32	NW	19	
[illegible]	few cirrus	15+	1011.5	93	30	E	6	
[illegible]		30	1010.8	88	36	N	8	
ONT	"	4 Haze		76	49	SW	11	
VNY		8				SE	~~to~~ 12	
FUL	broken cirrus	10				S	10	

Fri, May 24, 1968

5 PM

NOT REPRODUCIBLE

[illegible]	Clouds	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	Remarks
[illegible]		8	1016.0	68	55	SW	11	
[illegible]		20		73	49	S	9	
[illegible]		15	1015.9	75	48	WNW	9	
[illegible]		20	1016.3	69	52	NW	13	
[illegible]		20	1016.3	65	49	SE	8	
[illegible]				58	28	N	19	
[illegible]	overcast cirrus	6 Haze Smoke	1014.4	75	49	W	13	increasing Haze Smoke
[illegible]	broken cirrus	10	1014.5	74	44	NW	10	visability higher S
[illegible]		3 Haze		74	43	NW	7	
[illegible]	broken cirrus	20		83		NW	22	
[illegible]	Few cirrus	15+	1009.8	91	32	—	0	
[illegible]		30	1010.2	93	34	NW	7	

ONT	5 Haze		74	50	SW	11
VNY	10				SE	12
FUL	10				S	7

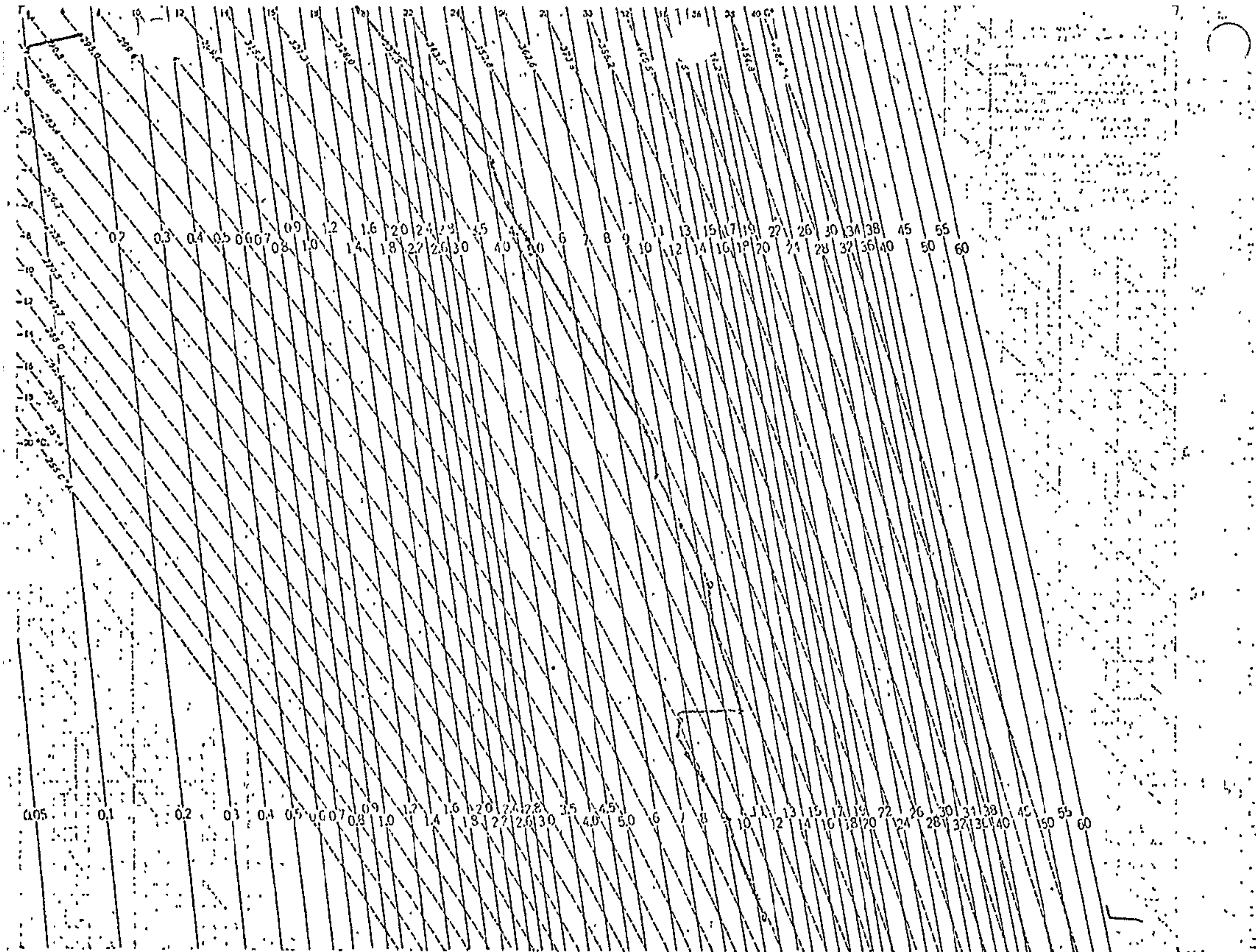
Friday May 24, 1968 HOUR 6 PM

Pacific Day[illegible]

NOT REPRODUCIBLE

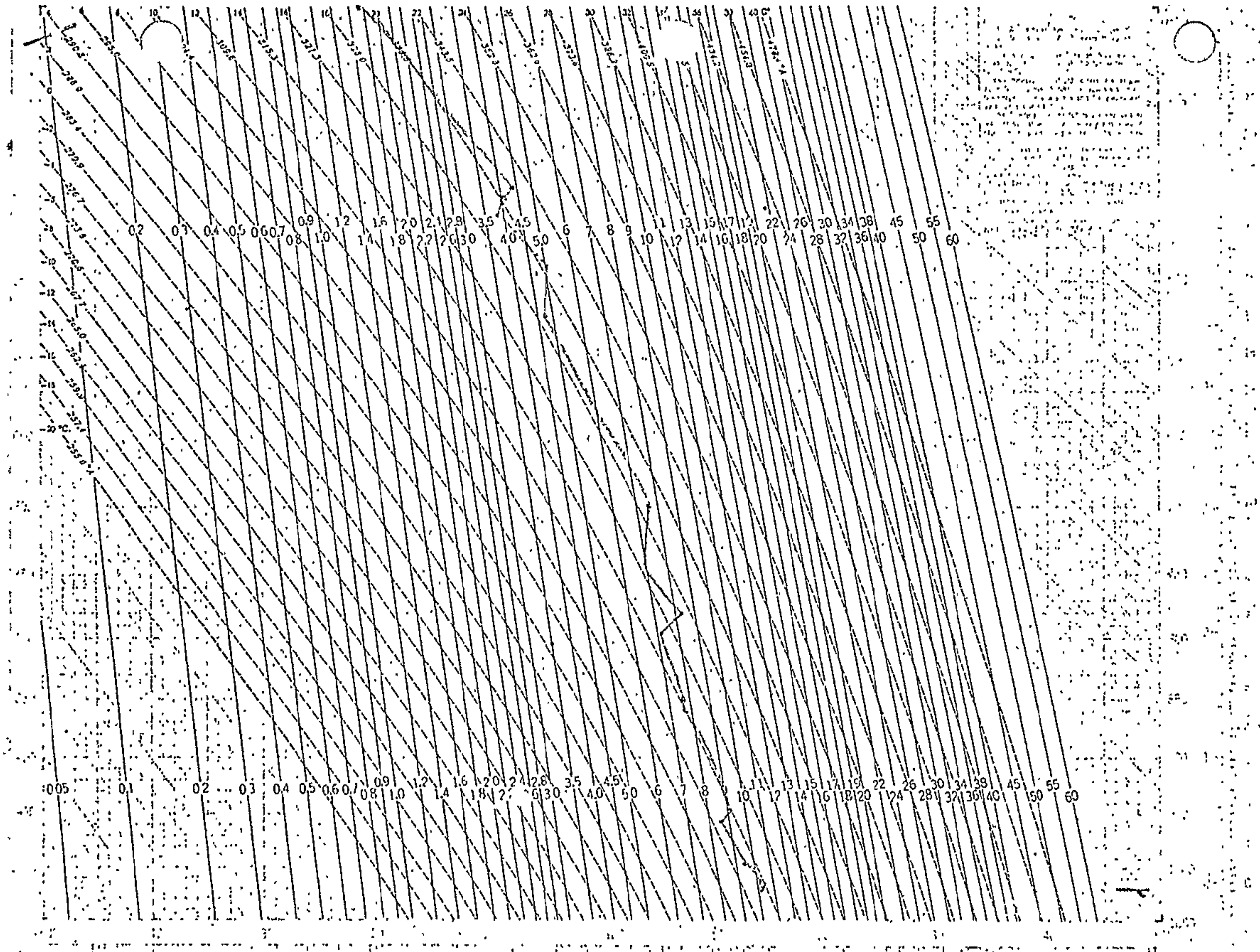
[illegible]	[illegible]	Visibility	Barometric Pressure (MB)	Temperature	Dew Point	Wind Direction	Wind Speed	Remarks
[illegible]		8	1015.8	67	54	SW	10	Few cirrus N
[illegible]		20		72	49	S	5	
[illegible]		15	1015.9	72	48	W	12	
[illegible]		20	1015.9	67	53	NW	11	
[illegible]	Few cirrus	20	1016.3	65	49	SE	7	
[illegible]				56	27	NW	20	
[illegible]	broken cirrus	6 Haze Smoke		73	50	WSW	8	
[illegible]	Few cirrus	10		72	44	NW	8	Gusts 15
[illegible]	—							
[illegible]	"	15		87		NW	21	
[illegible]	"	15+	1009.8	93	33	W	5	
[illegible]		30	1009.8	90	35	N	7	

ONT



D 42

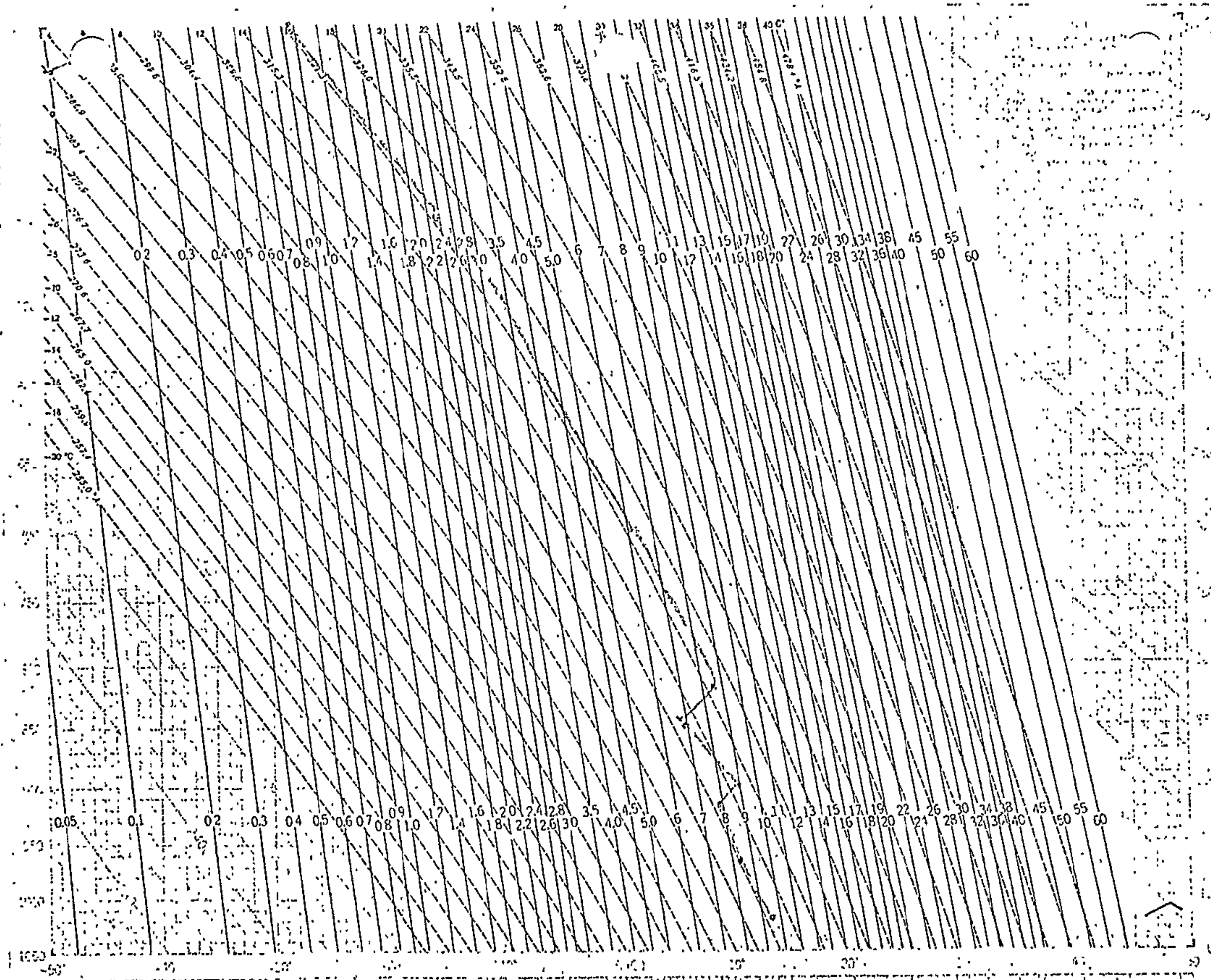
LAX May 21 211330Z 0600 PDT Tuesday



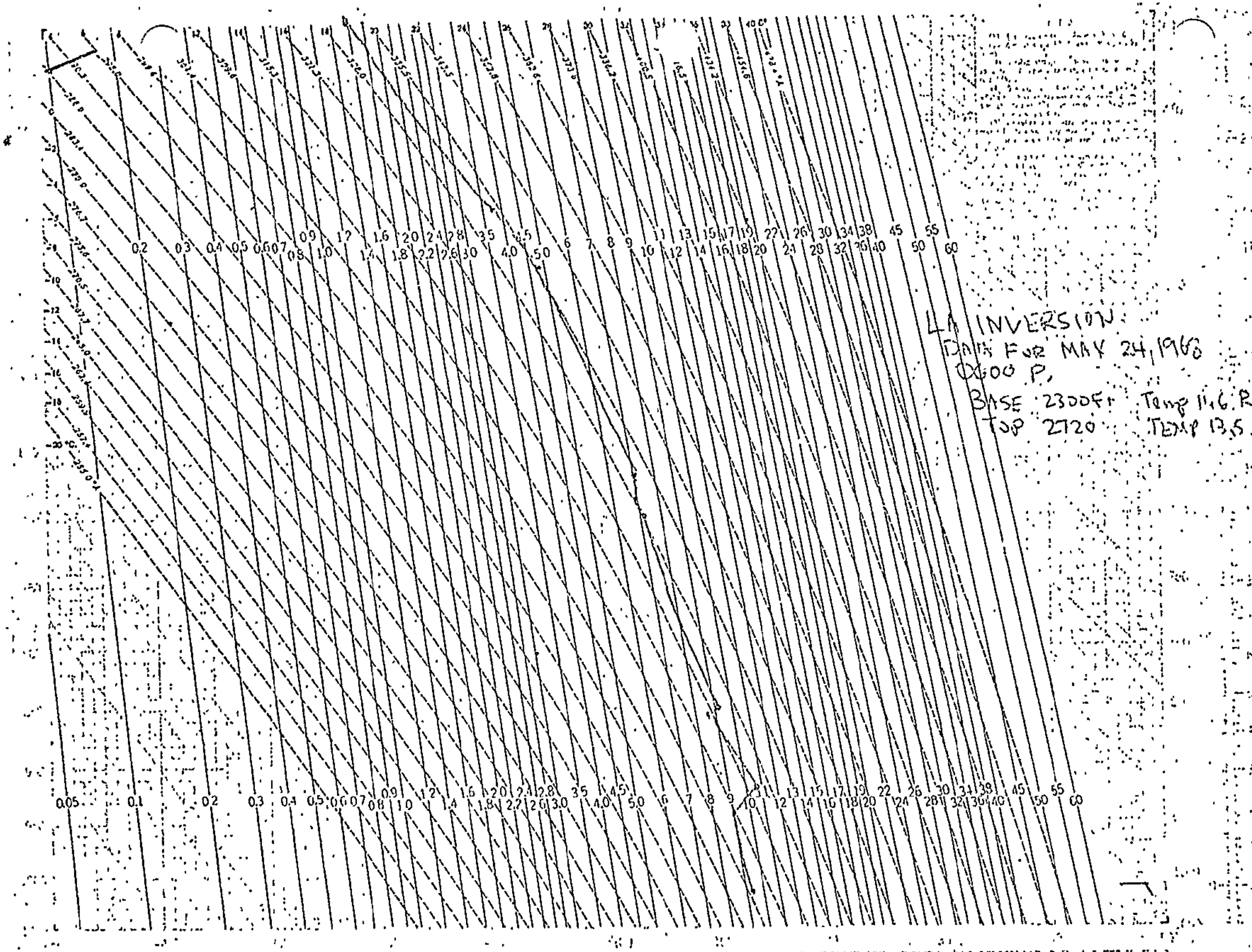
LAX May 22 0600 PDT MORNING Wednesday

D 43

D 44



Station LAX Date Thurs May 23 0600 PDT Thursday



LA INVERSION
DATA FOR MAY 24, 1968
0600 P.
BASE 2300 Ft Temp 11.6 RH 54
TOP 2720 TEMP 13.5 RH 4(

D 45

LAX May 24 ~~24234~~ (ng 5.0) 0600 PDT FRIDAY